THE

MILLER

AND

MILLING ENGINEER

BY

CHARLES E. OLIVER

Chas. E. Oliver.

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Miller and Milling Engineer

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Expert Miller and Milling Engineer

FIRST EDITION

INDIANAPOLIS, INDIANA, U. S. A.

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CONTENTS

PREFACE

When the writer first conceived the idea of publishing this book he had most particularly in mind the benefitting of those millers who have to operate mills in isolated places. It is not possible for such millers to gain that knowledge and experience that their more favored brethren have who are living and working in localities supplied with mills of the most modern construction and with every known system, and where it is possible for operatives to converse with each other and compare notes, exchange ideas, and thus mutually assist each other.

There are no doubt millers who enjoy all the modern advantages that will not be interested in all that this work contains, but the writer is convinced that there are those who will, and there is a demand for a work elementary enough to aid the class of millers first alluded to and yet be of service to those of wider experience and greater opportunities. This will be sufficient apology for the mention of many details that some readers may regard as superfluous.

This work is based on the practical experience of the writer covering thirty-five years, and has stated facts and not theories, and writes without bias to any system, machine or principle. His sole purpose has been to produce a work that would be helpful to his brother millers.

No attempt has been made to pad these pages to an undue length; and nothing has been introduced except that which every miller should know something about. Possibly there are some who will object to the introduction of steam engineering into the work, but there are unexpected opportunities for a miller to display his knowledge in steam engineering when least expected, and there are times when millers have to operate mills with inexperinced engineers, and it is greatly to his own safety to keep a close watch on the engineer and also the engine.

Regarding the plans and diagrams in this work it need hardly be said that being for the instruction of those who have knowledge and some experience in the art of milling and its mechanism, no attempt has been made to show every detail, for that would make the work too expensive and difficult of accomplishment. The writer deemed it unwise to cover page after page with explanations of plans and diagrams when to men who have the least knowledge of the art they are self explanatory. It has been the desire nearest the heart of the writer to do something that would be of lasting benefit to my fellow operatives, and having worked my way from the bottom rung of the ladder until I reached the top I know what a struggle it is and I always wish to do by others as I would they should do unto me.

If this work, the result of a plan long cherished, should prove helpful to some, it will have served its purpose.

The
Miller and Milling Engineer

CHAPTER I.

HEADMILLER, FOREMAN, OR SUPERINTENDENT.

The most important feature in the correct running of a mill is the headmiller, foreman or superintendent, and upon him generally rests the responsibility of making a mill a success. Any mill with a capacity of 200 barrels upward should employ the very best miller possible to obtain. He should be placed in full control, receive sufficient compensation to make him satisfied with his position, and he should be given to understand that he must render faithful service. The headmiller must be such in word and deed; he must have good executive ability in order to rule the men placed under his supervision; he must give his orders and see that the men obey such orders; he should be conscientious, painstaking, civil, unselfish, gentle, considerate, very intelligent, and know his business to the uttermost in order to rule men and make a mill thoroughly successful. Millers are not made in a day, month or year, and in order that a man may rise to a higher plane in his profession he must study constantly, read all the milling journals and milling literature he can, and never miss an opportunity to gain any knowledge relating to his chosen calling. It is a simple matter to run a mill when one is competent, but my how hard when one does not have the knowledge, and how soon the mill is running the miller, and to see a miller in this predicament is very amusing, and there are thousands of such millers, and more is the pity. The headmiller should at all times show consideration to those under his care; he should never use profane language, and if he does he deserves a whipping; he should never show a jealous disposition; he should give civil answers to his men when asked regarding information relating to milling, for it might be of lasting benefit to the apprentice, himself, and the millowner. A headmiller ought to give the best and purest advice to those under him, for kindness in this respect will linger with them the rest of their days, and how much better to be remembered as a good man in after years and get good words, than to be thought of as a bad, domineering spirit; and how much better to be a philanthropist than a misanthropist. Avoid making enemies, it does not pay; it is often dangerous to life and property, and to study revenge is foolish and a waste of God's precious time, and always devolves on your own shoulders.

When I was a superintendent over six mills it was always a source of the greatest pleasure to give advice and instruction to those working under me, and I have had some of the most pleasant reminders from those whom I have assisted in that way; and only a year ago I received a beautifully pleasing letter from a headmiller who said in part, "*If it had not been for your friendly advice I would have been a laboring man today;*" and such words are well worth all the trouble it gives one.

Millers should at all times guard against the affliction known as self conceit, for we never know it all, and I have received some very valuable tips from my understudies, and not because I did not know how to do a thing, but he taught me how it could be done more expeditiously.

Self conceit leads many a man into the idea that he knows all about the correct running of a mill just because all is running so smoothly under his headmiller, and at the first opportunity he risks his reputation and accepts the headmillership, only to find that the mill is running him instead; and my advice to such men is to stay under a good headmiller until thoroughly competent to operate a mill correctly.

To gain a higher position a miller must attend strictly to business, have your employer's interest uppermost in your mind at all times; study all possible in the time that others are wasting foolishly; keep eyes and ears open to gain every advantage possible that will spell advancement in your chosen field; know the why and

wherefore of every machine in the mill and how to adjust its every part; never think you know everything there is to know, for therein you fail in ever being a competent miller.

Should you at any time desire an advance in salary take that desire to the mill-owner, superintendent or manager; place it before him in a mild and concise manner, and in turn, give them time to think it over carefully before deciding, and invariably it will be forthcoming; but should we go to them in a blustering manner and demand an advance or we would immediately resign, in all probability the resignation would be accepted, and often taking effect at once.

Unless you have made up your mind to sever your connection with your firm, do not fly into a tantrum and say, "If so and so is not done I will resign," for you might be let out at a moment's notice, which might prove very inconvenient in many ways, and especially financially. As a little example of the way such matters turn out I relate the following:

The superintendent of a large factory would, upon the least provocation, fly into a tantrum, rush to the office, and even curse the proprietor and say if so and so was not done he would leave at once, and being a very valuable man the proprietor would pacify him and all would be well. One day he did that very thing when a son, just out of college, happened to be in the office, and after the superintendent had gone into the factory, he said to his father, "Father, what would you do should that man die, for I know that this factory could run without him?"

The father's answer came immediately, "How strange I never gave it a thought in that light. Call him and pay him off forthwith"; and his place was filled at once.

Always remember that a man is never so valuable but what another can be found to fill his place, and very often for the better.

A headmiller ought always to be given sufficient assistance to run his mill correctly, and should have something to say in regard to the men who are to be his assistants; and should really be allowed to hire his own men, and should be held responsible for them and their work.

In American mills, generally speaking, there is an insufficiency of helpers allowed, and the headmiller is often called upon to do work that would be more profitable to be left to cheaper help, and the mills are run with much less help than mills of like capacity in the old world.

Millowners should not expect their millers to be responsible for their mills and the products and at the same time expect them to attend to customers, oil the mill, do the cleaning, grinding, grading, purifying, wheat cleaning, and all manner of roust-about work, for it is penny wise and dollar foolish policy, and everything generally becomes as it ought not to be, and the result generally a mill that is a failure.

The miller that is running a mill under the above conditions is never satisfied with his position if he may be called a miller; and should a good customer happen along when the miller was in the midst of a choke, and had to wait an hour, or until his patience was exhausted, he would undoubtedly leave not to return, which would cost the owner the price of another hand to do such work.

Millers should never undermine their brother operatives; it is cowardly, dishonorable; it never gains them anything, but on the contrary they are invariably out of employment. They should at all times lend their brothers all the assistance they can, and should they get out of a position take the next best thing to be obtained to hold until such times as an opportunity presents itself to re-enter the mill in an honorable manner, but not to go and undermine your brother by offering to run the mill at so much less salary, and many do this very thing. I know of an instance where the superintendent of a large mill was sent on a visit to Europe at the mill's expense to gain all the knowledge possible, and while he was absent his headmiller undermined him completely, and he stepped out.

There are headmillers that deserve all that can possibly come to them, and there are some that really know so little about milling that deserve all they generally do get, and should a man come along at the time they are going to be let out it is no fault

of theirs if they secure the the position if offered them. It was my lot when starting up my second roller mill to have a foreman that was one of the meanest men it has ever been possible to meet anywhere; it was impossible to get out of him a civil answer; would sneak around to do dirty mean tricks, instead of being a man to stand up and tell what he desired, and such a man ought not to have charge of men. Again there are a class of men in mills that will stoop to the most dastardly meanness that is possible, and will resort to anything in order to get even for what are often imaginary wrongs, and I have had men that I have assisted in many ways and who were jealous of me, throw off belts, place obstacles in spouts, perforate bolting cloths, etc., and were sometimes found out and discharged.

There is in a mill a place for every man; every man should be in his place and know that place; and that man should have a place for everything and everything should be in its place; and always remember that if anything is worth doing it is worth doing well.

If a man is a miller in every sense of the word he will be able to fill any place in a mill, and patience and study will assist him in gaining the summit of his profession.

To get the best there is in the workmen it is well to be kind and affectionate one to another at all times.

Chapter II.

KEEPING THE MILL CLEAN.

Nothing is more revolting to a man or miller of refined sensibilities when going into a mill and finding it in undisturbed possession of oil, tobacco spit, cobwebs, dust, dirt, bugs and all the innumerable concomitants of the slovenly miller, and how a competent miller can work in such a place is beyond my comprehension.

There is no place that gives greater delight to a real miller than that of a mill kept in that perfect order a mill should at all times be kept, and what is there that is prettier than a mill that is neatly painted, spots varnished, shafting as bright as bells, machinery free from grease, floors free from oil, walls whitewashed, every corner clear of dirt and dust, bugs an unknown quantity, and tobacco juice not in evidence?

If a mill is kept spotlessly clean in every part it is seldom in possession of bugs or vermin, for they can not thrive in a clean place as a general rule, yet how many mills you see with every corner piled like a pyramid with flour and meal, making them a breeding place for all manner of insects.

It is difficult to be neat and orderly unless the instinct is there, but perhaps a few observations may serve to show the lax brothers where to begin. There is no ploce on the wall or floor of a mill for anything but what is absolutely necessary for the correct working of said mill; if the article is small, have a receptacle in a convenient place for it; if large hang it up in a convenient and unseen place.

When the mill floor and walls are free from unnecessary articles of every description, it is an easy matter to keep the mill looking spick and span at all times, and for the simple reason that dirt can not be hidden. The sweeping and cleaning of a mill seems very simple, but I assure you there are few who really know how to do it, and one thing is to be borne in mind: "Take care of the corners and the open spaces will take care of themselves." It is a fact that there are operatives in charge of mills today that could not hold the position of a sweeper in our large mills for the reason that they can not sweep clean.

Machinery requires cleaning daily; the floors require cleaning whenever necessary. Do not leave empty bags, twine, meal or anything around, for they are liable to catch fire from spontaneous combustion.

All the spare time of employes ought to be given to fighting dirt, cleaning and brightening all shafting; cleaning off grease from every part, and in this way the mill can be kept clean.

There are mills that I visit in which it is difficult to distinguish between wood and iron on account of the perfect way in which oil and dust have done their work, the bearings being unrecognizable in many instances. A putty knife is one of the best instruments to clean the grease from floors and machinery, and it is handy because it may be carried in your pocket; and it is also handy in tightening up a screw when in a hurry. I have often been astonished how anyone could use the flour of some mills that I have seen in my travels, for they were littered from basement to roof with all manner of filth, and how any man, and especially a miller can work in such a place is beyond my comprehension; but they were always loafing when they had an opportunity to shine up. A clean mill is a valuable asset in building up the trade of the mill and retaining that trade, and when it is kept spotlessly clean it is soon known far and near, and the products become known as being made in a spotless mill. It is a good advertisement for any mill to have a visiting day, when your townspeople can be invited, and demonstrate to them just how the flour is manufactured, and you will be astonished how the women will talk about it to everyone they meet for days afterward. All people speak well of a clean mill, but a dirty mill is an eye sore to all people; so my advice to all is to have a clean mill or no mill at all.

Chapter III.

GRAIN ELEVATORS.

Grain elevators ought to be planned and diagrammed by an expert in the receiving of grain of every description. The building should be alongside of the railroad to receive and ship the grain and products that may be manufactured; all grain should pass the first stages of the cleaning in the elevator so as to prevent any dirt or dust passing to the mill; all feed ought to be ground in the elevator when in connection with mills of 200 barrels capacity and over. The other side of the elevator from the railroad ought to be arranged for an easy entrance for farmers' wagons; with dump for all grain; with scale in connection with the dump, and everything ought to be of the most modern construction, with the weighing and receiving arrangements the most simple in order to get the farmers, for they generally take their grain where there is the least work in unloading. Be sure to have the capacity of the receiving elevator above the capacity rather than below, and a saving in first cost in this instance becomes very expensive when they are in actual operation, and the buckets ought to be at least sufficiently large to receive 1,000 bushels per hour for small elevators, then there is no time wasted by the men as very often is the case with elevators that are too small.

When building an elevator it is well to eliminate all conveyors when possible, and it can be done by having the elevator heads high above the receiving bins; and the boots sufficiently low to allow the fall.

Wheat only needs about 30 degrees to travel down a spout when the wheat and spout are in good condition. All grain should pass a receiving separator before being sent to the receiving bins in order to remove everything larger than the grain passing, or there is all kinds of trouble when drawing the grain from the bins by choking at the slide.

The elevator foreman ought to be a very reliable man, one who is a good judge of wheat, and to be able to test his grades, detect all the diseases prevelant in grain, and to be a judge of the moisture contents of the same.

The foreman ought to be a miller by trade in order to attend to the manufacture of all kinds of feed. An elevator should be built very simple, and very strong, and with all machinery above rather than below capacity, which prevents chocking, saves much time and expense, and it is always ready to receive the grain in a hurry which is very often the case when several cars arrive at one time, and wagons galore awaiting their turn on the otherside to be unloaded.

Again, the foreman ought to be a fair mechanic, for it falls to his lot very often

to repair things in a hurry, and there is little time to send and await the arrival of a millwright or carpenter.

The foreman must be a pleasant and congenial personage in order to ingratiate himself into the good graces of our farmer friends, for they are very appreciative for favors as a general rule, and they are very quick to resent any inattention on the part of mill officials.

The foreman must be as sharp as a fox in order to detect the deception of some farmers, for there is nothing too low for some of them to stoop to to gain an advantage over the mills or elevators.

I have caught farmers doing the following: Weighing themselves on the load and trying not to be weighed as tare; mixing in sand, screenings, rocks, and even water; also weighing their foot, sacks or anything else it is possible to do. A passenger elevator is absolutely necessary in an elevator in order to have the men do their utmost for employers, for if an employe has to climb to the top of an elevator several times daily he is of little use for other duties.

The arrangement for delivering wheat to the mill for grinding must be at the command of the miller when necessary, or at the signal from the mill; and should be sent to the mill by a spout rather than a conveyor whenever possible, for it is a saver of power, it is less expensive in every way, and the wheat reaches the mill more expeditiously.

All elevator legging in an elevator ought to have an exhaust attachment so as to draw in all dust and make it possible to keep a clean house, for it is the best of policy to keep it as clean as the mill, and it can be done.

Chapter IV.

THE BUYING OF GRAIN.

Just as much discrimination is needed, as much judgment can be exercised, and as much profit made in the purchasing of wheat as in any other branch of the milling business.

There are many things to guard against when buying wheat or any other kind of grain, and it behooves all grain buyers to be constantly on their guard, or they will be caught napping to their detriment.

A good and competent grain buyer will detect instantly the defects of wheat brought to him to pass upon, and there are a great variety of diseases prevelant in wheat.

When buying wheat it is necessary to guard against the following: Smut, must, sprout, weevil, binburn, immaturity, white caps, cockle, chess, amount of screenings, amount of moisture, sand, gravel, actual test, and anything that is not a grain of wheat.

Always pay higher for the dark flinty berry than that of a white chalky nature, for the former is more profitable in every way, and it makes better flour.

Smutty wheat is very obnoxious on account of the offensive odor, which is very difficult to remove, and should the smut ball become damp during the harvesting the smut ball bursts, the black, grimy and very foul smelling dust becomes embeded in the fuzz end of the berry, and also in the crease, and the only way to put the wheat in milling condition is to pass it through the laundrying process, where the wheat passes through a stream of clear water, only remaining in the water about a minute at the most, when it passes to the dryer before the bran is soaked through, and it is easily dried.

Must is the very worst of wheat diseases for the reason that it is not possible by any known process to remove the obnoxious odor.

Wheat mixers will mix and scour and rescour to try and deceive the buyer, and I have seen some sharp buyers taken in by it to their sorrow. Sprouted wheat may be blended with good wheat according to how badly it is damaged, and it is known by the small sprout adhering to the germ end of the berry.

Bin burnt wheat has a peculiar odor unable to describe, and differs from sprouty grain because it is dry, and the sprouted is generally damp.

Immature wheat is devoid of starch and is not good to grind unless blended with good wheat.

The moisture test is one to guard against when buying grain, and on corn especially or much money can be lost. The average moisture of wheat is about 12%, yet it will carry as high as 19%, and on your purchase you ought to be allowed for the extra moisture.

Weevil eaten wheat is very bad to treat if allowed to stand too long, as there is a very foul smelling dust from the refuse of the weevil when mixed with the wheat dust, and it becomes embeded in the fuzz end and the crease, and it is hard to remove.

When buying, be very careful to get all that is coming to you, but it is very unwise to try to take any advantage of a farmer, for if he finds it out it passes to others like wildfire, and the mill is often ruined; but on the contrary, do not let the farmer take advantage of you, for he will do that very thing up to 50% of them.

The only correct method of purchasing wheat is by test, and the half-bushel tester is the most accurate for this purpose, and it ought to be filled by pouring in the wheat, but upon no account to knock the tester, or you make 58 pound wheat test 62 pounds.

The standard ought to be 60 pounds test, and for every pound over test allow one cent per pound; and for every pound under 60 pounds deduct one cent per pound to 56 pounds, when you ought to deduct two cents per pound to 52 pounds, and below 52 pounds it may be bought for chicken wheat or for feed.

The above is on sound wheat, but on infected grain you must use your own judgment, and if you buy it at all get it as cheaply as you possibly can, or there is no money in its use.

In some states the mills and elevators are allowed to dock the farmers for chess, dirt, etc., and they ought to be docked for it, for if they are paid for it they soon mix more of it whenever possible.

The best and only method when buying wheat is to run it over a separator, the machine to be where the farmer may see it; and give the farmer his dirt and screenings; or a better method is to buy the screenings at the best price and sell them for chickens, or grind them.

If the farmer takes the screenings back to the farm you get more seeds the next year, or you give him a chance to mix them with another batch of wheat and take and sell it some place where they do not use your separator method.

In olden times it was a criminal offense to walk across a barn, or warehouse floor when anyone was testing grain, and it is well to think about that very thing when filling and stroking the tester; and the tester must be stroked with something square, with a perpendicular side in front or it has a tendency to push the wheat into the tester.

It is dangerous to buy damaged wheat from a farmer if you are running a country mill, for he will tell all his neighbors about it, and then you will have complaints about your flour.

If a farmer insists upon giving you off grade wheat on exchange just tell him to wait and you will give him flour from his own wheat, and I warrant you he will not insist longer.

Every farmer has the best wheat in the county when he comes to the mill to dispose of the same, but be on your guard with them, for you will often find good at the top and bottom of the bag and bad or unsound in the center.

Treat all farmers equally and you will make many more friends for your future welfare.

Chapter V.

THE WHEAT BERRY AND ITS COMPOSITION.

Wheat has been cultivated since before the time of the building of the Pyramids of Egyt, and in all probability from the creation, and planted by God for the very purpose for which it is being used today.

There is no doubt but what it belongs to the family of grasses, and by cultivation has been brought to its present stage of usefulness to man and beast, and without doubt the most useful grain that is produced from mother earth.

Wheat is generally known in two species as summer and winter, or more commonly called spring and winter, but there are many varieties and from many different countries; these species are divided into many different varieties such as Egytian, East Indian, Australian, English, Russian, Turkey Red, white, red, amber, hard spring, medium hard spring, hard winter, medium winter, soft winter, durum or goose, yellow berry, blue stem, etc.

There are wheats testing from 50 lbs. to 66 lbs. per measured bushel, the former being very shrivelled and gradually filling until it reaches the grains fully enlarged to make perfect wheat.

Soil and climate have everything to do with the growing of wheat and giving us spring, winter, hard and soft varieties.

There are the flinty and starchy varieties of wheat, the former is the preferred for milling purposes on account of its gluten qualities.

Every miller ought to understand something about the composition of the berry proper to be able to get from it the products to give the highest satisfaction to his customers in order to build up a business on a solid rock.

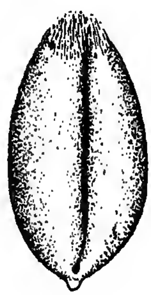
The wheat berry differs according to the variety in respect to the proportion of starch, gluten, nitrogenous matter, etc., of which it is composed; but the skeleton of the berry is similar in almost every instance.

At the flat end of the berry is a fluffy beard, which like the crease is a receptacle for dust and dirt which is very hard to remove, especially when it gets damp, when it is necessary to apply the washing process to make it pure for grinding.

At the pointed end is located the germ, or "embryo" and contains the phosphates and fatty matter, and is not suited to put in the flour in substance, but only as a flavor. It will discolor the flour and interfere with its baking qualities if not properly handled in the grinding process.

Figure 1 represents a perfect grain of wheat, "a" is the bearded end, "b" the base or germ end.

A.



B.

Fig. 1.

A PERFECT GRAIN OF WHEAT.

The composition of the berry proper is approximately the following—the crease being shown very plainly in the cut it is not necessary to dwell upon that further:

The first layer is the epidermis, or exocarp, or cuticle.

The second coat, or mesocarp, or epicarp, and consists of a row of long cells or vessels, are very light and without action, and is about one per cent. of the berry.

Layer three represents the endocarp, or last tegument, and is remarkable for its short and regular cells, and is about one and one-half per cent. of the berry.

The fourth coat represents the episperm, and is firmer in composition than the three preceeding it, the very small cells having two distinct colors, namely, pale yellow and orange, under this tegument is a fine colorless membrane, which, together with the episperm form about two per cent. of the berry.

Layer five is the tegmen.

Layer six is the embryous membrane.

Layer seven represents the endosperm or floury part of the berry, the large cells being the starch deposits. In the center is the softest part of the berry, which is mostly starch, and small amount of gluten, and are easily reduced by burr or rolls, the product having very little strength, and is unsuitable for making a light loaf of bread .

The embryous membrane which surrounds the center produces fine, white middlings, harder and more glutenous that that of the central part; its baking qualities being good; and it is about twenty-one per cent. of the berry.

When the preceding is blended with the forty-nine per cent. of the center proper the flour produced is of the finest quality, and makes the whitest bread.

The episperm or fourth coat is still richer in gluten than the embryous membrane, but during the process of milling it becomes blended with the bran and shorts, consequently passing to the lower grades of flour, making them more glutenous and stronger than the patents. This layer is the most nutritious. The aim of the process is to get all the gluten possible into the patent fiour, making it superior for bread making.

The bran constitutes the five outer coatings, and are easily removable by moisture and friction.

ANALYSIS OF THE WHEAT BERRY AND ITS PRODUCTS.

	Water per cent.	C. Ash per cent.	C. Protein per cent.	C. Fat per cent.	C. Fiber per cent.	Nit. free Ext. per cent.
White Wheat	9.5	1.8	10.7	1.9	2.4	73.7
Red Wheat	8.6	2.0	11.2	2.1	2.3	73.8
Wheat after cleaning	11.2	1.7	14.5	1.8	2.5	68.3
Patent Flour	8.7	0.6	8.7	1.1	0.3	80.6
Clear Flour	8.8	0.7	9.5	1.6	0.4	79.0
Low Grade	7.7	1.1	10.0	1.8	0.5	78.9
Red Dog	9.7	3.1	17.9	4.5	3.4	61.4
Flour Middlings	9.8	3.7	17.3	4.8	5.6	58,9
Fine Middlings	10.4	2.9	15.8	2.8	2.0	66.1
Coarse Middlings	9.5	4.3	17.1	4.9	5.9	58.3
Beeswing	11.0	2.0	7.6	1.7	16.7	61.0
Bran	9.1	5.6	15.5	4.5	9.6	57.7
Wheat Screenings	9.5	3.6	12.1	2.1	8.9	63.8

The above approximate analysis is really all that a miller wishes to know concerning his wheat in every day milling, and I am desirous of curtailing my unnecessary remarks in order to give more facts.

CHAPTER VI.

GRAIN OF CORN AND ITS ANALYSIS.

Corn for feeding purposes is most commonly used in America, and in England much corn is used in various ways for feed but not for table use. The corn crop of the United States averages about 2,800,000,000 bushels, and the products manufactured from the growth of corn is numerous and are about the following:

Corn oil, corn cake, refined corn oil, rubber substitute, starch, gluten feeds, mixing corn syrup, crystal corn syrup, corn sugar, corn and cane syrup, several verieties of dextrines, many kinds of starch, glucose, corn meal, grits, cracked corn, feed meal, hominy, granulated meal, etc.

The pointed end of the grain contains the germ which furnishes the oil.

The outer teguments make our corn bran and go partly into the gluten feeds, but the corn itself is mostly starch as you will note later by the analysis.

THE ANALYSIS OF THE GRAIN OF CORN:

	Water per cent.	C. Ash per cent.	C. Protein per cent.	C. Fat per cent.	C. Fiber per cent.	Nit. free Ext. per cent.
Corn	10.7	1.6	10.5	5.1	2.1	70.4
Corn Meal	6.0	1.5	8.4	4.7	2.0	77.0
Corn and Cob Meal	8.3	1.3	8.9	3.6	5.0	72.9
Cob Meal	6.6	1.8	2.1	0.5	31.4	57.6
Corn Bran	9.3	2.3	9.6	5.9	7.4	65.5
Germ Oil Meal	9.1	2.0	22.0	11.9	9.8	45.2
Hominy Meal	8.2	2.2	10.0	6.7	3.5	69.4
Hominy Hearts	8.4	6.4	13.4	21.9	5.5	44.4
Hominy Feed	7.6	2.5	10.5	9.0	4.5	65.9
Gluten Feed	7.8	4.0	26.5	2.6	8.2	50.7
Corn and Oats Chop. 30 per cent. Oats	6.5	2.4	8.4	3.7	3.9	75.1

The above is an approximate average of the products, and will allow millers to determine the percentages of their concentrated feeding stuffs, and their relative values for feeding purposes.

CHAPTER VII.

RYE, OATS, BARLEY, FLAX, BUCKWHEAT, RICE, COTTON SEED, CLOVER AND ALFALFA, AND THEIR ANALYSIS.

	Water per cent.	C. Ash per cent.	C. Protein per cent.	C. Fat per cent.	C. Fiber per cent.	Nit. free Ext. per cent.
Rye	12.4	1.9	10.7	1.6	2.3	71.2
Rye Middlings	8.5	3.8	15.5	3.2	5.1	63.9
Rye Bran	10.6	2.7	14.4	3.8	3.7	64.8

OAT ANALYSIS.

Oats	10.3	4.2	11.3	4.5	10.2	59.5
Oat Meal	6.5	2.0	14.0	6.7	1.5	69.3
Oat Middlings	7.1	2.2	14.4	6.6	3.0	66.7
Oat Bran	5.8	5.2	11.8	5.5	15.2	56.1
Oat Hulls	7.7	6.5	3.2	2.0	32.1	48.5
Oat Screenings	9.0	37.2	12.8	2.4	10.0	30.6
Oat Clippings	11.1	14.5	12.9	3.0	18.9	39.8

BARLEY ANALYSIS.

	Water per cent.	C. Ash per cent.	C. Protein per cent.	C. Fat per cent.	C. Fiber per cent.	Nit. free Ext. per cent.
Barley	10.1	2.6	12.0	2.3	4.9	68.1
Barley Flour	10.0	1.1	8.6	1.3	0.6	78.4
Barley Meal	9.4	4.2	11.7	2.6	10.3	61.8
Barley Shorts	10.4	3.4	12.0	3.5	10.1	60.6
Barley Screenings	10.0	6.5	10.5	2.7	14.8	55.4

FLAX SEED ANALYSIS.

Flax	3.6	3.3	23.5	37.6	5.4	26.6
Flax Seed Bran	6.9	5.0	17.5	2.8	34.8	33.0
Flax Seed Meal	6.6	3.3	23.3	40.1	5.3	21.4
Flax Screenings	10.0	7.7	15.3	12.5	15.8	38.7
Linseed Meal, old process	8.5	6.0	32.2	9.1	8.7	35.5
Linseed Meal, new process	8.4	6.4	34.7	3.2	9.5	37.8

BUCKWHEAT ANALYSIS.

Buckwheat	8.6	2.0	11.3	3.1	10.2	64.8
Buckwheat Flour	8.2	1.8	13.2	2.9	1.5	72.4
Buckwheat Midd's	9.7	6.5	27.6	7.8	9.6	38.8
Buckwheat Bran	6.1	2.5	11.5	2.2	41.8	35.9
Buckwheat Hulls	9.9	2.5	5.0	1.1	43.3	38.2

RICE ANALYSIS.

Rice Uncleaned	11.5	4.7	6.1	1.5	8.8	67.4
Rice Cleaned	11.6	0.8	7.0	0.5	0.4	79.7
Rice Meal	9.4	10.0	11.4	9.8	9.7	49.7
Rice Bran	6.6	19.6	3.5	0.9	39.2	30.2

COTTON SEED ANALYSIS.

Cotton Seed	7.1	3.9	20.6	20.5	21.6	26.3
Cotton Seed Meal, the average	8.2	5.5	35.5	7.2	11.0	30.6
Cotton Seed Cake	5.5	5.4	41.4	8.1	8.8	29.8
Cotton Seed Feed Meal	7.6	4.2	20.0	5.2	22.6	40.4
Cotton Seed Hulls	8.4	2.4	3.6	1.7	44.3	39.6

CLOVER SEED ANALYSIS.

Clover Seed	8.2	3.9	36.4	8.3	9.6	33.6
Clover Meal	9.0	9.1	15.2	1.6	24.6	40.5
Clover Seed Scgs.	9.5	6.3	31.5	6.4	12.5	31.8

ALFALFA ANALYSIS,

Alfalfa Meal	9.5	8.7	14.7	2.0	28.1	37.0

Chapter VIII.

TESTING, TREATMENT, BLENDING, TEMPERING AND CLEANING WHEAT.

The correct method of testing wheat is to sink the tester into the grain, fill it by hand or scoop without touching the tester, and stroke it with the tester beam or lath, being very careful to have the stroker perpendicular, or the test will be incorrect.

Never use a round stroker, or employ a slanting motion when stroking, as it has a tendency to press the wheat into the tester, making an incorrect test, and detrimental to the buyer.

WHEAT TREATMENT.

Smutty grain of any variety is very annoying, and every farmer ought to take great care to have pure seed before sowing it.

Smut is caused by a parasitic fungus, and it is carried over from year to year by adhering to the grain, and when it is growing and just heading the fungus enters the young berry, and the dark, grimy and foul soot is the result.

In fields badly affected it may be detected during the harvesting of the grain, the odor reaching long distances.

Smut in wheat is detected immediately by an experienced mill man, and he can judge almost instantly its true value.

When the smut ball is broken it may be treated by spreading it on a dry floor, and after drying it, mix about 100 lbs. of slacked lime dust, and turn it once or twice daily for several days, then pass it two or three times through the cleaners until it is clean, when it may be blended, say 2% to 5% according to its damaged condition.

If the grain is very smutty it is the best policy to wash it thoroughly by passing it through a stream of clear water, allowing it to remain about one minute in order not to soak the bran, then pass it to the dryer, when it is ready to blend 5% to 10% with sound grain.

When wheat contains dry smut it can be drawn out by a strong blast on the separators and smutters, the ball of smut remaining intact, and being lighter than a grain of wheat.

Of all diseases of wheat, musty is the most objectionable for the reason that there is no known process that can effectually remove the objectionable musty smell, or the musty taste and make it sweet for milling purposes.

Wheat dealers will scour and re-scour again and again, and polish it to deceive the buyer, and I have seen many taken unawares and have had the wheat reach the first break before detection, but after it reaches the first break it is easily noticed by the musty odor.

I have never lost by having musty wheat, as I always manage to blend it in the percentages to get rid of it without its being noticeable, and each miller must be his own judge regarding the percentage to blend, for he is familiar with its condition.

I would not advise blending over 5% of it with sound wheat, and then it must not be very musty or it will be noticeable; and from 2% to 5% is about correct. Musty wheat should be kept very dry and kept moving to keep it from getting worse. It is a good policy to pass it at intervals over the separators to give it fresh air.

Sprouted wheat is not so bad unless it is too far advanced in germination, when it is weakened to such an extent that it is dangerous to blend over 2% with sound wheat.

It has been proven that wheat that has sprouted, and the sprout is as long as the berry, it will make fine bread; and when it commences to sprout it will make the finest bread possible to make.

Should the sprout be over the length of the berry it should be blended not over 10% with sound grain; and should the sprout be over half an inch in length it should be mixed not over 2% to 3% with good wheat.

Sprouted wheat must be kept dry and moving, or it will soon be beyond the blending stage.

Weevil eaten wheat is very offensive when very badly affected with the little pests, and it requires much scouring and brushing; and often has to be thoroughly washed to make it ready to mill.

In weevil eaten wheat there is a very malodorous dust that becomes embeded in the beard and crease of the berry, and unless the wheat is washed it must be scoured very thoroughly to remove it sufficiently to blend and grind.

It is not safe to mix over 10% with sound wheat, and from 2% to 10% according to the damaged condition of the wheat.

Bin burnt wheat is similar to smutty wheat and ought to be treated and blended in about the same proportions.

Immature wheat is not good for milling purposes, as it is deficient in starch, is full of white caps, and will make a runny dough, and consequently a soggy loaf of bread, and very dark.

Blend in about the same proportions as that of musty wheat, and with wheat of good strength.

White caps in wheat are not relished by a careful miller, as they are both deficient in starch and gluten, and will not bake alone, as the flour is without life.

They can be drawn out by the blast of the cleaners, as they are only about half the weight of an ordinary wheat berry.

White caps make good screenings or feed, and may be used for blending with oats when making chop feeds.

Cockle is objectionable if the wheat contains over 5% of it, and there are special cockle machinery for its removal, and are obtainable from all mill furnishers. The cockle machine is a solid cylinder, with round indentations large enough to hold the cockle seed and a grain of wheat, and as it revolves slowly the wheat falls out at about one-third of the ascent, the cockle falling out at about one-half the ascent into a long tray with conveyor, which carries it to the tail of the machine. When wheat contains more than 5% of cockle—the hull being black as jet—it gives the bran and middlings a dirty, speckled appearance.

The cockle seed is the poppy seed, and it is poisonous if eaten alone, and is not good if milled in too large quantities in grain.

It is a round black seed about 3/16-inch in diameter, the interior being lilly white. A rolling screen with perforated zinc is a fine scourer, and a splendid seed separator providing the number of the perforations are correct numbers for the seed in your district.

The perforations must be kept clear of all obstructions or good work is not possible.

There is always a method of using almost any kind of wheat to prevent total loss by blending just the percentage that the good wheat will allow in order for the flour to pass muster when placed on the market.

I always got rid of wheat after it was bought no matter what its quality was, and I never had flour returned as unsalable unless it was on a declining market, for then there is always trouble.

The blending of grain in many countries is a fine art when done correctly, as there are wheats from all countries on the globe milled there. In England where the author served his apprenticeship there are wheats of every known variety ground there, and a miller and wheat buyer must know his wheat and how to blend it in order to make satisfactory flour, and of average uniformity.

Think for a moment upon the following blend: 50% English soft red for color and flavor; 20% East Indian, washed, for strength, color and flavor; 10% Russian Saxonka, thin, reddish and flinty for strength; 10% Russian Kubanka, thin, reddish and flinty for strength; 10% Australian, plump and medium hard for strength, color and flavor.

To temper the above mixture, the East Indian is washed, the Russian is dampened,

and all are run together and sent to tempering bin to temper for 6 to 12 hours when they are in condition to pass the cleaners for the removal of beeswings, and make it ready to grind.

In the United States there are many varieties of wheat for blending, and it is becoming an art to blend correctly in order to get the flour to give perfect satisfaction; yet it is not so difficult now as twenty years ago.

Hard and soft wheat ought never to be dampened together, for the soft will be too damp or soft, and the hard will not be soft enough.

The day is coming when there will be little notice taken by the housewife regarding hard and soft wheat flour; and even today they are using both for bread or pastry, where formerly they would use spring for bread only, and soft winter for bread and pastry.

The blended flour is going to be the flour of the future, and that is the flour that is going into every home in England today without distinction, and is used for all purposes, and giving the highest satisfaction.

It is the best policy to wash all the hard wheats; dampen the medium hard, and blend them with the soft varieties and let them temper for 6 to 12 hours before cleaning.

While the wheat is tempering it will expand and crack, and while passing the cleaners for the last operation the outer cuticle will be removed in the form of beewings, or transparent, red tissues if coming from the red varieties; or amber tissues if from the white varieties of wheat.

A simple tempering arrangement when desiring to blend the hard and soft at one time is the following: run the percentage of hard through the dampening conveyor, giving it enough water to make one grain adhere to an other, then mix the percentage of soft with it, send it to the tempering bin for 6 to 12 or 18 hours, and you will find that the soft draws sufficient moisture to put it in correct condition for milling, and the hard will be tempered just equally with the soft, and after passing the cleaners they will be in the finest condition possible for milling, the bran being toughened, and the berry uninjured, and a better yield is the result, with whiter and better flour on account of the absence of specks from the chipping of the bran.

Do not upon any consideration whatever dampen any variety before it has passed at least one scourer, and better still to have passed the whole of the cleaners if the wheat is very dirty, for there is always dust lodging in the crease or fuzz, or beard of the berry, and which is easily removed while the wheat is dry.

When wheat is being received carrying 15% to 17% of moisture, and at the same time it is sound and clean, it may be mixed with good dry wheat to the amount of 20%, sent to the tempering bin for about 30 hours, when it will have put the dry into good condition, and itself being dried sufficiently to mill and make good and satisfactory flour.

It is absolutely necessary to wash the Egyptian, East Indian, China, Russian, and many of the South American wheats, as they all contain dirty, foreign matter, which can only be effectively removed by the laundrying process.

The wheat blender must understand the difference between the hard and soft, and the flinty and starchy varieties of wheat in order to blend for the manufacture of flour to give perfect satisfaction.

The man on the ground must be the judge regarding blending according to the various condition of the grain to be milled, and according to the moisture and sweetness of the same.

There is no use for any miller allowing any wheat to be thrown away if he will only use his judgment, for he can make money for his employer in this respect if he will take the trouble, and the time he is being paid for.

In winter time or when the wheat is cold it is good policy to run it through the steamer to heat it, which puts it in better condition for grinding.

When tempering wheat to grind with live steam be very careful not to cook it,

or the germ oil will permeate the berry, discolor the flour, and injure the gluten, making unsatisfactory flour all around.

The blend most satisfactory for families is the following: 60% soft winter, 40% hard winter or spring, making a 75% to 85% patent, which they will use for all purposes.

The bakers like pure spring or pure red Turkey wheat flours because they absorb the most moisture, consequently making the most loaves, and adding to their bank account, and while we cannot blame them for that, yet it is the best of policy to make the bread that keeps moist and sweet, and is the most satisfactory to the housewife.

A very satisfactory blend for flour that always satisfies is the following: 50% soft winter, 30% hard winter, 20% of spring No. 2 N. making 85% patent.

The following blend would be good in England for a very satisfactory flour: 40% English for color and flavor; 10% hard spring American or Canadian for strength and bloom; 10% Australian for color, flavor and bloom; 20% Chilian or Plate for color, flavor and bloom; 20% Russian for strength.

It is possible in England and the continent of Europe to make any kind of a blend on account of being able to get wheat from all over the world.

There are wheats that will take on as high as 8% of moisture, but they must be kept moving almost daily or they soon become musty.

If wheat is dampened too much and sent to bin to stay it will sweat, and soon ferment, which will soon injure the gluten cells, consequently lowering the strength of the flour.

CHAPTER IX.

WHEAT CLEANING, CONDITIONING, AND SCREENINGS REDUCTION.

In Fig. No. 2 is given flow Sheet No. 1 which gives the full process of a modern wheat cleaning plant, with dampener, washer, conditioning bins, and the separation or reduction of the screenings.

After the wheat leaves the receiving elevators it must pass the receiving or warehouse separator in order to take out every thing larger than a grain of wheat or smaller than a grain of corn or maize, so that the wheat may be drawn from the receiving bins without the chocking of the slides, which would prevent a correct blend.

No. 1 machine on the flow is the receiving separator or warehouse separator, and it is needless for me to give complete explanations about the construction of the various machines, for that may be obtained from the catalogs of the different makers of wheat cleaners and milling machinery, so I will make it as clear to the minds of the readers of this work the parts to look after when they are in operation.

The air currents on cleaners, the same as the purifiers, must be unobstructed from the place of entry at the various points, to the entering in at the fan, and the suction ought at all times to be stronger than what is actually required so as to be equal to its task under all conditions of the weather, which has a great deal to do with air cleaning machinery.

If anything is nailed to a machine great care must be exercised in order not to interfere with the air currents, for I have found sacking nailed all around where the wheat enters and where it leaves the machine, which makes it impossible to do its correct functions. All around the spout where the wheat enters the machines, and where it leaves it, there must be at least three inches of clear space, so that the air may enter all around and pass through the wheat and suck every thing smaller than a grain of wheat into the screenings where it belongs.

Keep the sieves of the separators perfectly clean, if not of the latest construction which have automatic cleaners attached, for every hole stopped up takes away just so much cleaning capacity.

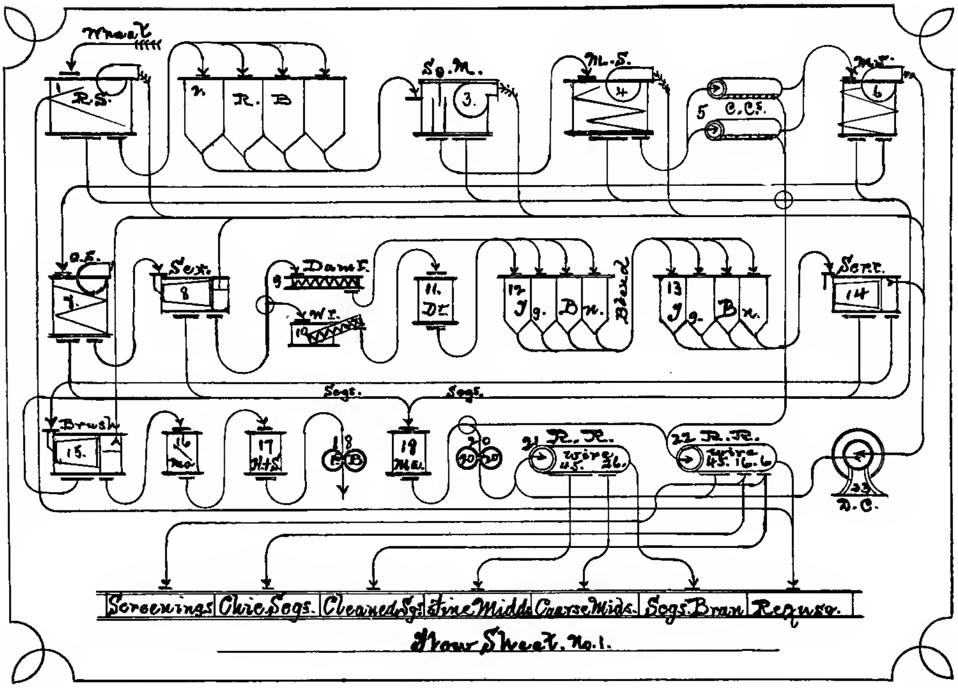


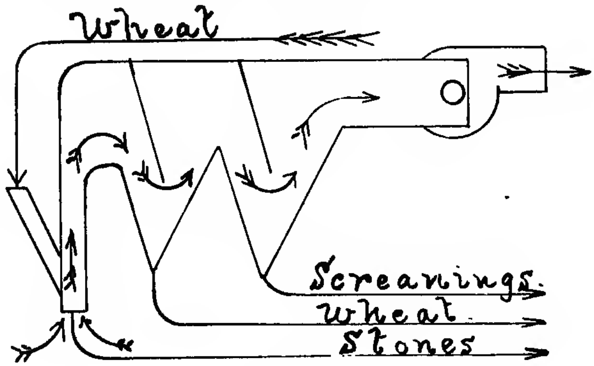
Fig. 2.

Examine every machine under your supervision with care at all times to see that every bolt is tight, and that every part is doing what it was built to do, and if there is anything wrong with it see to it that it is made right, for therein lies so many mill failures.

No. 2 on the flow are the receiving bins, which ought to be arranged to blend when necessary.

No. 3 is a stoning machine which has to be used in some countries to take out small gravel about the size of a grain of wheat, and which can not be taken out by the other machinery.

In Fig. No. 3 you have a diagram of the action of the air current on the stoning machine, and you will notice that the wheat is lifted bodily, and the stones being



No. 3.

heavier than the wheat drop into a box at the first operation, the next slide taking the wheat, and the third the screenings, and it does a perfect work.

Machine No. 4 on the flow is a milling separator, the air current passing through the wheat as it enters the machine, and also as it leaves it, and must be just strong enough to draw out every thing inferior to a grain of wheat, but not a grain of wheat.

A visiting miller once remarked to me "I see you do not have any wheat in the screenings" and I said, "Why should there be, when the cleaning machines are made to separate the screenings and the wheat correctly."

Machines No. 5 are the cockle cylinders, or poppy seed separators which does its work well, and an explanation of which you will find in a preceding chapter.

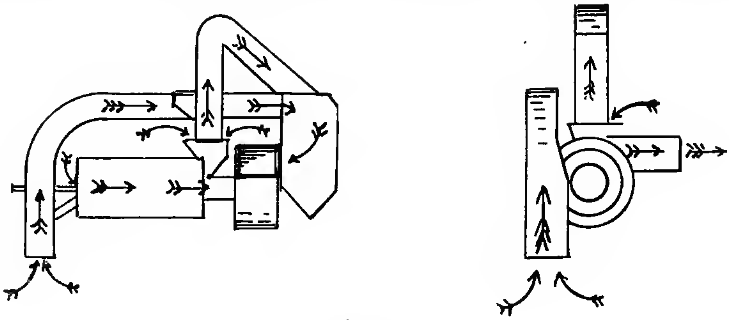


Fig. 4.

No. 6 on the flow is a milling separator the same as No. 4.

No. 7 is an oat separator which makes a perfect separation of the oats from the wheat, making it possible to market them for pure oats.

Machine No. 8 is a scourer, and in Fig. No. 4 you get a good description of the air currents on its course to the fan, taking dust and all in its path to where it belongs.

You have a cross cut and longitudinal cut in Fig. No. 4, the wheat entering at the center of each cut.

No. 9 on the flow is the dampening conveyor which ought to be arranged to use hot or cold water; and it may also be arranged to act as a steamer and heater, and when acting as such it has to be made of iron. This conveyor need not run over forty revolutions per minute.

No. 10 is a wheat washer, the wheat passing into the conveyor through a pool of water, from there into the steam whizzer or dryer, afterwards to be blended or sent to tempering bins.

No. 11 on the flow is the dryer or whizzer, which drys the wheat so perfectly that it will contain only about two per cent. more misture after leaving it than what it contained before going to the washer.

No. 12 is a set of tempering bins in which may be placed the wheats to be tempered and blended, and they ought, to blend correctly, to have automatic measures at the outlet to measure accurately the amount of wheat of each variety passing to the blend.

I have worked blenders in the form of a water wheel, having buckets with slides that could be removed at will, and each having twelve buckets, the slides could be moved to allow as many as required to be open, giving an accurate amount of each grade.

No. 13 are also tempering bins where the wheat tempers before passing the cleaners for the last time in order to remove the beewings, caused by the expansion and contraction of the berry during the cleaning and tempering process.

No. 14 is a scourer same as No. 8.

No. 15 is a brush, scourer or polisher which ought to be the last before the

wheat goes to the rolls in order to remove the remaining dust, etc. While the scourer, polisher or brush is acting upon the grain and removing the dust, the air currents are passing through the cylinder or case and removing it.

The brushes or beaters of the scourers ought to be set about $\frac{1}{4}$ to $\frac{3}{8}$ of an inch from the case in order to do correct work and not break the berry, or much waste is the result.

The main thing is to be sure that all the inlets and outlets for the air are unobstructed in the path it ought to move, or poor cleaning is the obvious outcome.

No. 16 on the flow is the magnetic separator, the working type being the most satisfactory, as it is seldom that any metal passes it. Metal passing to the rolls is very hurtful to the corrugations, and in many instances will spark and cause a dust explosion, and who knows but what the same thing results in the burning of some mills.

It is seldom that metal passes the separators if they are running properly, and have the sieve kept clean.

No. 17 is a heater and steamer, made to use both live or dry steam to warm the wheat just before going to the rolls, and care must be exercised in order not to use too much live steam, or the germ oil will penetrate the berry proper and give a decided yellow cast to the flour, and will also injure the gluten.

No. 18 on the flow is the first break roll.

No. 19 is the magnetic separator for the screenings, and it is the beginning of the separating or grinding of the same, and in a fair sized mill it ought to be kept running continually, having an automatic feeding device in order to feed the rolls uniformly.

No. 20 are the screenings rolls, with $2\frac{1}{2}$ to 1 differential; 20 corrugations, cuts, grooves or flutes per inch; with a "V" shape.

They ought to be watched as regularly as the other rolls in the mill, but strange to say they are often allowed to run themselves, and are often out of feed on account of feeder being obstructed by grains of corn, straw, etc.

No. 21 may be a round reel, hexagon, centrifugal, or force bolter, and clothed with wire or multi-metal, and the product sent to the regular mill feed as it is being milled.

This reel may be used when the screenings are to be ground, and when not to be ground this reel to be disconnected and stopped.

No. 22 may be a rolling screen, round or hexagon reel, clothed with wire from head to tail 45-16-6 the head to remove the dust and small seeds; the No. 16 to get chick feed for young chickens; the No. 6 to get nice, clean, coarse screenings for large chickens, which will bring more money on the market than the common run of screenings. Nos. 16 and 6 may be run together to make chicken screenings.

This last reel may be used for dusting all manner of grain if arranged for that purpose, and also for cracked corn, the No. 45 to take out the dust; No. 16 for grits or chic cracked corn; No. 6 for bolted cracked corn which will be about the size of wheat or rather larger, the tailings to be mixed and ground with chop feed.

No. 23 is a dust collector of any make desired, one large machine being sufficient for two sources if care is exercised in the installation.

All these machines are given in the different catalogs, and it is needless to take up space, and add to the cost of this book by so many cuts and illustrations, and I am giving only those which are absolutely necessary.

The separators are for the purpose of removing every thing larger or smaller than a grain of wheat, and also the dry smut balls, which are lighter than the wheat berry and can be removed before reaching the scourers to be broken, the grimy, black dust giving an offensive odor to the grain.

The scourer, brush, polisher, etc., are for the purpose of removing the dust, etc., adhering to the berry, and at the same time the air currents are removing the dust.

The following are splendid machines when in the hands of competent millers who know the why and the wherefore of everything connected with the mill: The

Eureka, Wolf, Beall, Monitor, Invincible, Victor, Barnard's Iron Prince, Richmond, etc.

The flow given in Fig. No. 2 is very long for a small mill, but it ought to be used for mills of over 200 barrels daily capacity of twenty-four hours run, and it can be shortened for smaller mills, and the machines increased for still larger mills.

Wheat from different countries and localities need different treatment to others, and to find out if the wheat is really clean enough to be ground, just get a sample from the first break, place it in a cup half filled with clean water, stir it for a few seconds, and see how dirty it makes the water.

By the courtesy of The Wolf Company, Chambersberg, Penna., who have given permission to the use of several of their excellent cuts, I present a cut of application of the steamer in water mills, which is difficult.

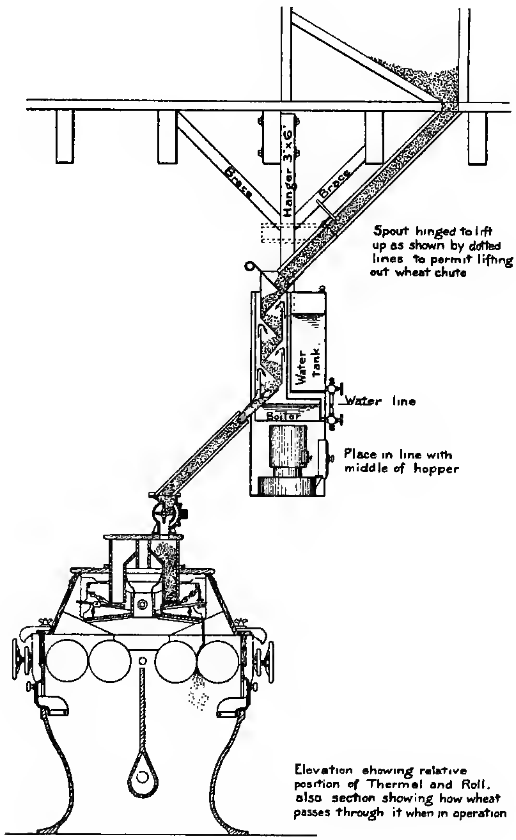


Fig. 5.

In Fig. No. 5 is shown the Wolf Thermal Steamer for wheat, showing its action from start to finish, and it explains itself in the cut.

CHAPTER X.

BREAK ROLLS AND BREAKING.

The greatest of care must be exercised in having roller mills perfectly level, the rolls must be in perfect tram or alignment one with the other, the brushes must be regulated to clean the rolls perfectly, boxes should be self oiling and truly babbited to make them run true, belts with glued flush joints to be noiseless, and power saving.

Do not upon any consideration allow break rolls to run empty, for running empty will do them more injury in five minutes than running with feed over one year.

Have the rolls recorrugated when they get dull if you desire sharp, granular middlings, and lively flour, for dull rolls take more power, make mushy chop, less yield, and soft flour.

Feed the rolls from end to end in a thin, even sheet, not leaving any surface uncovered or they become hollow, making it impossible to make uniform flour, and a close yield.

Have the roller belts tight, but not as tight as a violin string, but just enough to prevent slipping, for when too tight it causes the bearings to heat, takes unnecessary power, and reduces the life of the belt.

Wider belts are better than tight ones, and wider pulleys are preferable to narrow ones, and after the first cost are much more economical in saving power and belting.

Keep the roller belts clean and free from dust by holding a roll of gunny sack to the inner and outer sides, and drop about ten drops of pure castor oil on the driving side which will keep the belt soft and pliable, and will give the highest percentage of adhesion.

Do not feed heavily to cause the belt to buck and fly off, or slip, or the stock is generally mashed instead of chopped, making a mushy, mealy, sluggish chop.

The roller cleaning brushes must be set to touch the rolls with the end of the bristles in order to do good and perfect work, for to have them pressed against the roll until the bristles bend over, they simply press the stock more firmly against the roll instead of clening it off, and then the ring forms around the roll, causing it to jump, and prevent breaking.

Keep the framework clean, the shafting bright, and every thing spic and span and a miller will be proud of his mill under such conditions.

It is unwise to go below a three break mill, or there is no chance to get correct divisions of the stock in order to get the yield and quality. The 3, 4 and 5 break mills are preferable at all times.

My idea of a good corrugation is the "V" cut for the reason that it may be reversed when dull on the one side, making it possible to do almost twice the work with the sharpening. For hard and brittle wheat use saw tooth sharp on fast, to dull on slow.

Another fine cut is the flat top, with the circular cut, making the sharp, cutting edges, which are least affected when the rolls come together when empty on account of the flat top.

The corrugations are approximately for the following mills.

Corrugations on a 2 break mill are 16-26;
Corrugations on a 3 break mill are 16-20-26;
Corrugations on a 4 break mill are 12-16-20-26;
Corrugations on a 5 break mill are 10-12-16-20-26;
Corrugations on a 6 break mill are 10-12-14-18-22-26.

Differential on 2 break mill; 1st break 2 to 1; 2nd break or bran roll 3 to 1.

Differential on 3 break mill: 1st break 2 to 1; 2nd break 2½ to 1; 3rd break or bran roll 3 to 1.

Differential on 4 break mill: 1st break 2 to 1; 2nd break 2 to 1; 3rd break 2½ to 1; 4th break 3 to 1.

Differential on 5 break mill: 1st break 2 to 1; 2nd break 2 to 1; 3rd break 2 to 1; 4th break 2½ to 1; 5th break or bran roll 3 to 1.

Differential on 6 break mill: 1st break 1¾ to 1; 2nd break 2 to 1; 3rd break 2 to 1; 4th break 2½ to 1; 5th break 2½ to 1; 6th break or bran roll 3 to 1.

The most efficient spiral is one inch per foot.

Breaking on a two break mill: Come down on the first break about three-quarters or until the bran is just shaped, and care must be exercised to prevent the mashing of the middlings into flour; on the bran roll break down until the bran is just clean, but not to scrape it, as there are middlings to come from this roll, and not as fine as there are from the same roll of a three break mill.

Break for a 3 break mill about the following: 1st break about three-fifths; 2nd break just to shape the bran or about three-quarters, and bran roll just enough to clean and leave a slight imprint of the corrugations in the bran.

The breaking on a 4 break mill should be about the following: 1st break about one-half; 2nd break three-fifths; 3rd break three-quarters; 4th break or bran roll just enough to clean and leave slight imprint in the bran.

Break on a 5 break mill: 1st break two-fifths; 2nd break one-half; 3rd break three-fifths; 4th break three-fourths; 5th break or bran roll same as the preceding on 4 break mill:

On 6 break mill break the following way: 1st break one-third; 2nd break two-fifths; 3rd break one-half; 4th break three-fifths; 5th break three-fourths; 6th break or bran roll same as the preceding ones.

I wish to emphasize the importance of keeping the chop sharp, loose, mealy and granular in order to get large, round, sharp middlings, which can be dusted and purified perfectly.

The first sixing roll working on middlings, Nos. 16 to 24 G. G., is really or should be taken as a fine break roll, and this stock ought to be sized on corrugated roll with forty cuts to the inch, and be so adjusted that it will make the stock loose and granular, but not mashed right down to flour, for from this stock may be obtained some of the finest 2nd, 3rd and 4th grade middlings to be had in the whole process on a 4, 5 and 6 break mill.

The speed of the fast roll, 9 inches in diameter, should be at least 400 revolutions; on 7-inch roll, 600 revolutions; on 6-inch roll, 700 revolutions.

My speed on 9-inch roll is 500 revolutions for the fast one, and 750 on 6-inch roll.

Have the chop coming from each scalper perfectly dusted, and free from middlings, or dark flour results on account of making more break flour, which is always darker.

When breaking or grinding be sure to examine the stock at each end of the roll and at the center, which should be equal, and in this way it is possible to detect when rolls are out of tram or face.

To tram the roll: Set it up just as when grinding, have it spotlessly clean, clean the tram plate, put it on both rolls equally, tap it all over or at each corner, and adjust the rolls until there is no play beween the plate and the roll.

It is very important that the rolls should be in perfect tram in order to do good milling, and get close yield.

The saw tooth run sharp to sharp is poor policy when they are just from the shop, as they chip the bran, and give specky flour.

Running saw tooth cuts dull to dull is also poor policy, for as soon as the sharp edge is ground off, they make sluggish, mushy chop, take unnecessary power, make dead middlings, and soft, unsatisfactory flour with a poor yield.

With saw tooth it is the best policy to run the fast roll sharp, to slow roll dull, or sharp to sharp after the cutting edge has been worn off.

After setting the breaks in the morning it is very important that they be watched until they become warmed up, for they expand and contract according to the pressure and feed, and they grind according to that expansion and contraction, and ought to be examined about every hour or so.

After the breaks are set they should not be changed very much, for every time the grinding is changed it changes the stock throughout the whole mill, and generally the smooth rolls have to be re-adjusted.

Have the rolls perfectly level in order to have all the belts running in the correct position on the pulleys, for there is nothing looks better than a line of rolls when everything is running as it should be, and I want to emphasize the fact, that there is only one way to run a mill, and that correctly.

Many millers start their mill in the morning and do not look at the grinding throughout the day, and it is not possible to class such men as millers.

The approximate linear break surface is about 70/100ths linear inches per barrel of flour per 24 hours, or about 21 square inches per barrel in 24 hours.

The longer the system, the more gradual the reduction, the better the flour and the yield. The system has been cut down to such an extent that there is not the opportunity to break, grade or purify as it ought to be done, and it would be better to

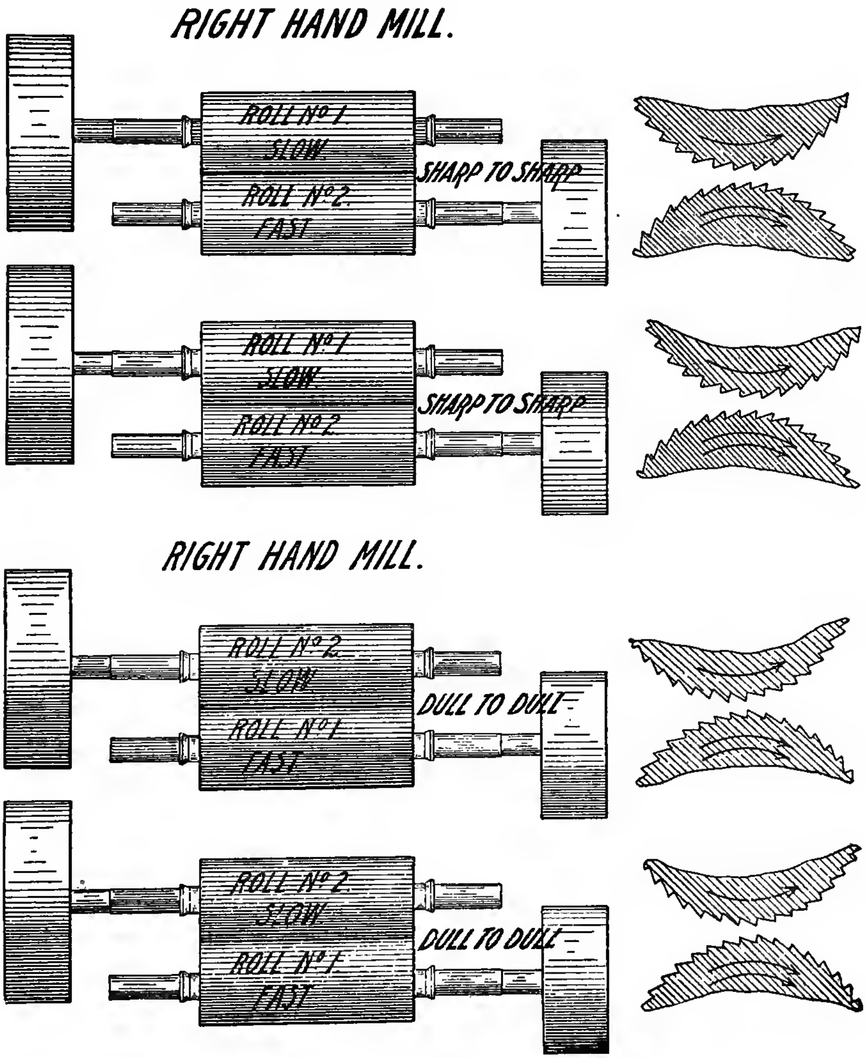


Fig. 6.

have seven breaks; five to seven sizings, and in that order there would be room for the correct grading of the stock from first to last.

Break to grade; grade to purify; purify to grind, and grind to bolt, ought to be the motto of every operative.

By the courtesy of The Nordyke & Marmon Co., Indianapolis, Ind., U. S. A., I present to you the cut descriptive of the left and right hand rolls, and which also show the manner of action of sharp to sharp, dull to sharp, etc.

In ordering rolls to be corrugated a miller does not want to forget that to get the action "sharp to sharp" the fast roll must have the cutting edge leading, and they slow roll the cutting edge following, for as the fast roll traveling so much faster than the slow roll it overtakes the slow roll and causes it to make the stock strike the cutting edge of the slow roll, and so many millers never give this a thought.

Fig. 6 explains itself, Chart No. 1 showing sharp to sharp, and Chart No. 2 dull to dull.

To find roller differential, use the following:

Revolutions of driving shaft, 200;

Diameter of driving pulley, 30 inches;

Diameter of fast roller pulley, 15 inches.

To find speed of fast roll: Multiply the revolutions of driving shaft by diameter of driving pulley, and divide the quotient by diameter of fast roll pulley, and arithmetically it is: $200 \times 30 \div 6000$ makes 400 revolutions for fast roll.

For slow roll:

Revolutions of driving shaft, 200;

Diameter of driving pulley, 20;

Diameter of slow roll pulley, 30;

Proceed as in the finding of fast roll speed, and arithmetically it is:

$200 \times 20 \div 400 = 30$ makes approximately 133-1/3 revolutions.

$400 \div 133\text{-}1/3$ makes about 3 to 1 differential.

Chapter XI.

GRADERS AND GRADING MIDDLINGS.

Graders or scalpers may be hexagon, or round reels, centrifugals, force bolters or sifters; the latter being preferable at all times, and the force bolters and centrifugals being most objectionable.

The sifters of recent years have come into general use as graders and dusters of middlings for the reason that they take less room and power, and the cloth cleaning devices are more perfected, giving a more unform grade of middlings.

Almost equal work may be done on reels to that of sifters if in the hands of a competent miller who understands his cloths, and how to keep the meshes clean, which is very important to insure uniform goods.

The cloths on both reels and sifters must be just tight enough so as not to sag, or not too tight to cause them to break; then they must have perfect cloth cleaning device; the belts must be just tight enough to do the work without slipping, castor oil being the only dressing needed; go over the cloth once or twice daily with hand brush to insure good work; tap the wire cloths on reels at intervals with a light switch it will loosen up the grit lodged therein.

Set the breaks to give the most possible of large sharp middlings; have the middlings perfectly dusted before going to purifiers from graders, or much good flour is wasted and the dust prevents purifiers from performing their correct functions.

I give you here the cloths for a four break reel mill for scalpers: 1st reel 8 feet,

head to tail, No. 45 wire, No. 26 wire; No. 18 wire; send siftings of No. 45 wire to dusting reel; siftings of No. 26 wire to No. 2 purifier; siftings of No. 18 wire to No. 1 purifier.

Reel No. 2: Nos. 50-30-22; No. 50 to dusting reel; 30 to 2nd purifier; 22 to 1st purifier.

Reel No. 3: Nos. 58-36-24; No. 58 to dusting reel; 36 to 2nd purifier; 24 to 1st purifier.

Reel No. 4: Nos. 60-40-30; No. 60 to tailings reel or some reel near the tail of mill; No. 40 to 3rd purifier; No. 30 to tailings roll.

Dusting reel 1/3 at head, No. 14 Silk, send flour to straight; 1/3 No. 60 Gritz Gauze, send siftings to 3rd middlings roll; siftings of tail to 2nd purifier through No. 44 G. G.

These cloths may be used for 3 to 5 break mill by using judgment.

I give here the grader cloths for a six break sifter mill:

Sifter No. 1: No. 18 wire, 34 G. G., 50 G. G., send 18 to 1st purifier; 34 G. G. to 2nd purifier; 50 G. G. to 4th purifier.

Sifter No. 2: No. 20 wire, 34 G. G., 50 G. G., send 20 to 1st purifier; 34 G. G. to 2nd purifier; 50 G. G. to 4th purifier.

Sifter No. 3: No. 22 wire, 34 G. G., 50 G. G.; send 22 to 1st purifier; 34 G. G. to 3rd purifier; 50 G. G. to 4th purifier.

Sifter No. 4: No. 24 wire, 44 G. G., 54 G. G.; send 24 to 3rd purifier; 44 G. G. to 4th purifier; 54 G. G. to 5th purifier.

Sifter No. 5: No. 30 wire, 50 G. G., 58 G. G.; send 30 to 3rd purifier; 50 G. G. to 5th purifier; 58 G. G. to 5th purifier.

First sizing sifter: No. 34 wire, 44 G. G.; send 34 to 3rd purifier; 44 G. G. to 4th purifier.

Second sizing sifter: No. 44 wire, 54 G. G.; send 44to 5th purifier; 54 to 6th purifier.

Keep sifter cloths free from holes in order to keep the stock uniform. The above arrangement will make the finest middlings.

Take particular notice of the flow sheets to see the method used in grading the middlings, for there it is easily traced from the head to the tail of the mill, the number of cloths, etc.

The aspirating scalper is a very fine machine in as much as it removes the impurities at the very beginning of the process and places them where they can do no injury to the higher grades of flour, and it is simply a strong current of air passing through the chop as it leaves the scalper after all dust has been removed. All the light weight impurities are removed in this manner.

Chapter XII.

PURIFIERS AND PURIFICATION.

The purification of middlings means everything to good milling, and it is a false idea to think that just as good flour can be produced without them, for that occurs only when the purifier is in the hands of incompetent operatives.

Before sending middlings to purifiers they must be correctly graded, and all the flour removed by the scalpers, for dust is an impediment to correct purification by clogging the meshes, and further, it is wasteful by sending good flour to the lower grades, and prevents close yields.

Every miller should have in his mill or office a first-class flow sheet of his mill which he may consult when necessary, for in a good flow sheet or "Modus Operandi" he has a guide at all times to the correct running of the mill.

It is bad policy to send middlings finer than will pass No. 8 cloth to a purifier, and middlings that fine will have to be absolutely free from dust or purification is not possible, besides being wasteful in power.

The feeder of a purifier must be as nearly perfect as it is possible to make it in order to feed in a thin, even sheet from side to side of the cloth, for unless the cloth is covered from side to side purification is impossible.

Air always passes the place of the least resistance, consequently the air in its upward flight passes the uncovered parts of the cloth, and the middlings pass impure to the rolls, and this is why an incompetent miller fails to observe the technical points and passes false judgment on the machine that is all important to white, clean flour.

Purifier cloths must be kept perfectly clean with automatic cloth cleaners, and by brushing with hand brush daily, or as often as necessary. The seive frame must be air tight to prevent the air passing that way instead of through the cloth and the middlings; eccentrics must be adjusted to prevent knocking of any kind, but not enough to heat the journals; the sieve hangers adjusted so that the stock will travel in a thin even sheet the full width of the cloth; and the springs adjusted to assist in the travel of the stock towards the tail of the sieve.

A purifier sieve to be correct in width ought to taper from head to tail as the stock becomes less in order to keep the cloth covered, making it possible to purify almost perfectly, and to have the sieve 30 inches at the head, and gradually taper to 15 inches at the tail, it is possible to have the cloth entirely covered.

The travelling brush must perform its correct functions at every stage, and the ends of the bristles just touching the cloth, for if the bristles press too hard against the cloth, they bend over, making the cleaning impossible.

Of all the types of purifiers that have been placed on the market there are none to equal the sieve machine when in the care of operatives who know how to run them.

Always have the fan power above its requirements so that it is available under all conditions of the weather, and in order to draw out anything that is necessary, for the feed varies with every change of wheat being ground, and it is annoying when there is not sufficient air to purify.

Air-belt purifiers and aspirators are preferable on coarse stock, and they require close attention to insure good work, and they are employed on middlings ranging from about No. 1 to 0000, and when the air is neatly adjusted their work is almost perfect, and only a competent miller can adjust them to do correct work.

The air in the purifier room should be kept as pure as it is possible to keep it, for dirty, foul air is a detriment to good milling.

Here again you need a flow sheet to guide you, for it is a difficult matter to explain the workings of purifiers without one, but I give you a description as best I can for a 4 purifier mill.

Purifier No. 1. Head to tail the cloth is Nos. 50-44-34-26-20 Gritz Gauze or G. G. is the term. This purifier is fed from No. 18 wire on the grader; the throughs that are pure go to No. 1 rolls; the throughs that are impure or about the last one-third of the sieve, go to the sizing roll to be cracked, bolted, graded and repurified, and which make the finest middlings in the whole process; the tail goes to 3rd break rolls, the same as that of 2nd and 3rd purifiers, for in this way anything larger than No. 16 G. G. middlings go to the breaks where they rightfully belong.

Purifier No. 2. Head to tail its Nos. are 54-50-44-34-26, it feeds from the throughs of the No. 34 G. G. on first three scalpers or graders; the head or absolutely pure middlings go to scratch rolls, or with the almost pure stock of about the first 2/3rds of the purifier going to No. 2 rolls to be ground right down; the remaining third to go to sizing roll for same purpose as from No. 1 purifier.

Purifier No. 3. Head to tail the cloth is Nos. 58-54-50-44-34 G. G., feeds from throughs of No. 50 G. G. of 1st, 2nd and 3rd graders, and No. 54 G. G. of 4th grader; the head or pure middlings go to scratch rolls, or to join with the almost pure stock to No. 3 rolls; the last 3rd of this purifier to sizing rolls.

Purifier No. 4. Head to tail the numbers are 64-60-58-54-50 G. G. or the following numbers of bolting cloth mav be used, 6-5-4-3-2; receives its feed from the various dusting reels that feed from the floury middlings of the graders, and which a flow can show you.

The following is the purifying system of a 6 break mill:

Purifier No. 1. Nos. 50-44-34-26-20 send the pure stock to 1st middlings roll, 1/3rd at the tail to sizing roll No. 1, tail to 3rd break roll.

Purifier No. 2. Head to tail Nos. 54-50-44-34-26 G. G. send pure middlings to 1st middlings roll, remaining sheets to germ middlings or 1st sizing roll, tail to 3rd break roll.

Purifier No. 3. Cloth numbers are 58-54-50-44-34, pure middlings to No. 2 middlings roll, tail sheets or 2nd germ middlings to 2nd sizing roll, tail to 3rd break roll.

Purifier No. 4. Nos. 5-4-3-2-1 XX silk bolting cloth; pure stock to No. 2 middlings roll; tail sheets or No. 2 germ middlings to No. 2 sizing roll; tail to 5th break roll.

Purifier No. 5. Nos. 6-5-4-3-2 XX bolting cloth; pure middlings of the head sheets to No. 3 middlings roll; tail sheets or about two-fifths to 4th sizing roll; tail to 1st tailings roll.

Purifier No. 6. Nos. 7-6-5-4-3 XX bolting cloth; pure middlings or about 3/5ths to 4th middlings roll; tail sheets or impure stock to 4th sizing roll; tail to 1st tailings roll.

Purifier No. 7. Nos. 7-6-5-4-3 XX bolting cloth, head sheets or pure stock to 5th middlings roll; tail sheets or impure stock to 1st tailings roll; tail to 2nd tailings roll.

The aspirating scalper is one of the finest systems for taking out impurities at the very beginning of the process and sending them to the tail of the mill.

The purifier is very important in that it removes the impurities at the very start, and in fact right down the line during the reduction and the sizing of the middlings, and send them to the tail of the mill which is their proper place, for it puts almost finished stock out of reach of doing any harm to the higher grades of flour, and eliminates fluffy stock from heavier stock, making it easier to flow, it saves power and increases capacity by not having to handle stock that is ready for the sack at the very beginning of the milling.

When these impurities pass into the system where the purifying system is used it is worked over and over again until it is worn out, or some of it has been forced into the flour, and such impurities are very detrimental to the flour, giving it a dark, dead finish.

Do not forget that the function of the purifier is to remove all the light impurities by the air current alone, and when the air currents are properly applied they remove all the light impurities to the dust room to be sent to the tail of the mill, and the other heavier impurities are being kept to the surface of the stock on the purifier cloth and carried towards the tail to be sent to the sizing roll, and when reduced, dusted, graded and repurified make the finest middlings in the mill.

By the air currents keeping the inferior stock to the surface of the travelling stock on the purifier cloth it makes it possible to take out the pure stock at the very beginning of the milling and reduce it to flour, to be sent direct to the packer.

No, brother millers, do ont upon any consideration discard the purifier, but rather put in all the mill can stand, and take pains to adjust them to do exactly what they are built to do, for you can make better flour with them than without them, and the only trouble is when they are run by incompetent operative millers.

I sold a purifier to a party who was a millright but not a miller, he set it up and put it to work as he thought, and after a year I called upon him and he told me that the middlings were just the same after leaving as they went onto the purifier, and my first glance at the machine told me the reason; he had the fan belt running backward. We changed the belt and what a tickled man he was after I had put it to work and showed him the result, and his flour gave much better satisfaction. That occurred in a mill in Talcahuano, Chili.

By sending the tailings of the purifiers working on the coarse middlings to breaks it is possible to catch all larger than No. 16 G. G. middlings and return them to the

breaks to be reduced there instead of them going to the rolls to cause them to jump. By sending these tailings to breaks it will often prevent the closing down of the mill when one of the scalper cloths break, by being able to return the stock to the breaks.

It is very important during cold or damp weather to keep the windows and doors of the purifier room closed, yet do not fail to give the fresh air purifiers plenty of air, for they require it in order to perform their proper functions, yet do not allow a draft to blow on the purifier, or the middlings will be irregular, for they require a steady air current.

An automatic feeder is very essential in order to prevent an unsteady feed to a purifier, or correct work is not possible.

A feed with a spring attachment that will keep the feed at one level, or the entire width of the feed roll, but it must have a set to prevent its opening wide in case of an overflow of feed during a choke, etc.

Overfeeding of any machine is the cause of all manner of trouble, and prevent it whenever possible, for it spells loss to the pocket-book whenever it happens, as flour finds its way to the feed pile.

In the old world there are many kinds of the dead air type used, and they consist of a plate above the sieve consisting of narrow troughs, the air and impurities passing between them, and as soon as it is above the plate the impurities drop into the troughs and are conveyed or shaken to the outlet. The fan in these machines run about 120 revolutions, and the air outlet is back into the mill in some instances, and others go to the dust room.

Purifiers give much trouble at intervals by the stock banking on the cloth, or running to one side of the sieve, and this may be accredited to various causes, namely, sieve hangers, motion, eccentrics, springs, etc., and the man in charge must persevere until he discovers a remedy.

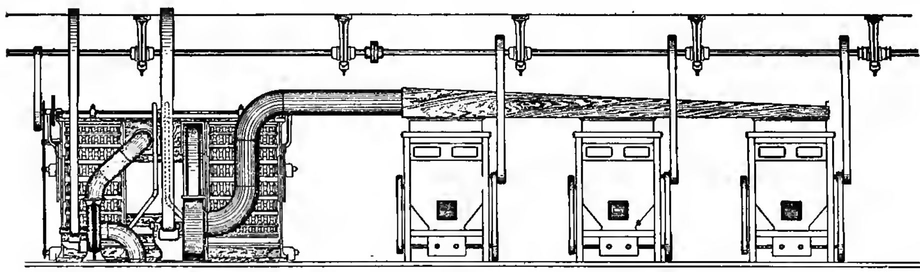


Fig. 7.

The purifiers is where a return may be made to advantage in order to keep the cloth evenly covered.

The speeds of purifiers vary according to conditions, and fans run from 120 to 800 revolutions, according to the type of machine.

Purifiers must be perfectly level crosswise, and should be lower at the tail to cause the stock to travel more freely, and the sieve adjustments allow for the lowering of the tail of the sieve.

It is very important not to allow the least air to enter above the sieve, or purification is out of the question.

Purifier belts must be glued joints, and just tight enough to prevent slipping, or uneven stock is the result.

There are so many intricate parts to a purifier that it behooves the operator to be on the alert at all times to see that it is in first class condition, for when it is in perfect running order it is a pleasure to see it run and perform its splendid work.

The fall of the sieve should be about a $\frac{1}{4}$ of an inch per foot.

Keep the purifier windows clean so that it is possible to see the action of the air

currents on the stock, and the air must enter beneath the cloth and pass up through it and through the middlings in its flight to the fan, and that is its main object, so see to it that nothing impedes its course.

Be sure that all the air passages are kept free from impediments, for meal will lodge there and block the trunks completely.

Fig. No. 7 shows the arrangement for the connection of the dust collector with the purifiers, and is constructed on correct principles by having the graduated exhaust trunk.

Chapter XIII.

SMOOTH ROLLS AND MIDDLINGS REDUCTION.

The correct reduction of middlings is the most difficult task of the operative miller, for they vary so much in so many respects, necessitating different treatment at every roll that it takes the finest judgment of the operative to the most delicate point, and a man cannot be careless and be a good grinder.

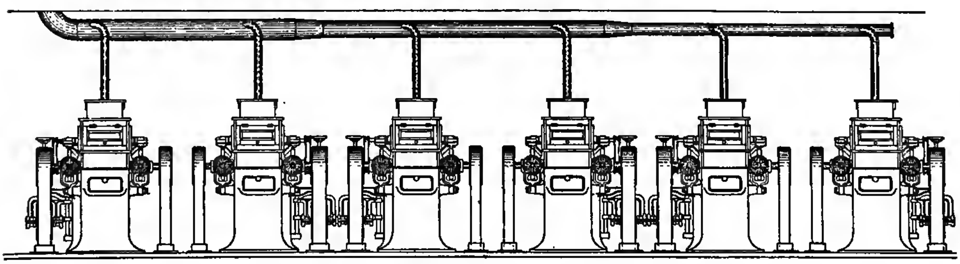
To grind correctly the miller must do all in his power to keep the hands soft and silky so as to have that delicacy of touch so essential to good and correct grinding, and it shows here the reason why a millowner should not ask his miller to do all manner of roustabout work and think he is saving so much by it, for in reality he is losing money by his miller neglecting the most important work of all, that of attending to his mill.

High speed rolls are objectionable on account of the extra power required, the heating of the boxes, and the wear on the belting.

Rolls must be perfectly true in face, and in perfect tram or alignment, or good and perfect grinding is an impossibility.

Exhaust for roller mills is very essential, and especially if the basement is cold, causing the evaporation of the heat in the stock, causing the spouting to be lined with dough, and become warped, together with the elevator legging.

Never, if it can be avoided, attach the exhaust to the underside of the rolls, as the air always rises, also the steam, and when the connections are made above the rolls the work is half done, and it is a perfect arrangement.



Roll exhaust and the air separations from three purifiers operated by an independent fan blowing into a double collector.

Fig. 8.

I would not run a mill for a moment if it was my own without the exhaust attachment, for besides keeping the moisture from the spouts it acts as a suction and a dust collector for the rolls and elevator legging, the dust going in instead of pouring out as is so often the case.

In Fig. No. 8 you have the exhaust arrangement for a line of rolls, and with the graduated exhaust trunk, which insure equal suction from each roll, and is more apt to keep itself clean than a square trunk of equal size the entire length.

The rolls must be in perfect level on the floor to insure the correct running of the belting on the face of the pulleys.

A roll of any description must be fed from end to end in a thin, even sheet, or good work cannot be accomplished, it takes less power, and gives closer yields.

Always feel the grinding at each end of the roll, and at the center also, for in this way you detect when rolls are out of tram, or hollow in face.

There ought not to be the eighth of an inch of surface left without feed at the ends of the rolls, or rings will form, causing the rolls to whistle, and also prevent the rolls coming together, the ring being the highest in face.

After setting up the rolls in the morning when cold do not leave them all day without readjustment, for they change according to the expansion and contraction of the iron by the heating and cooling action.

If you find a roll very warm and grinding very close, do not open it up and leave it for long, as it cools it will open further, and will not grind at all, and soon cause a deficiency in the yield.

Have the knives or scrapers adjusted to do their work perfectly, and keep the rolls absolutely clean, or grinding is impossible.

In Fig. No. 9 is given the cross section of the Wolf Roller Mill, showing the arrangement of the scrapers, the feeding device, and at "a" the place for the attachment of the exhaust.

This is a very fine cut and I produce it just as it is taken from the Wolf magnificent book of machinery.

Do not overcrowd the rollers, it wastes power, the stock is unevenly ground, and often not ground at all.

Specks at the head of the mill are not so injurious as those at the tail, for often the specks at the head are balls of flour in a granulated form, while those at the tail are all feed, and impart a dark cast to the flour.

It is seldom that more than 3 to 1 of a differential has to be used on rolls, but it has to be resorted to on a short system mill on the last or tailings roll in order to get a good finish.

Do not allow unground middlings to pass the ends of the rolls, for it causes an irretrievable loss, and on the breaks it may be caught, but on the smooth rolls not possible.

For grinding or softening pure middlings there is nothing to my mind that will equal the corrugated roll when using cuts to correspond with the number of the middlings, and may be from 30 to 100 cuts per inch, the latter being used on the No. 8 middlings.

Corrugated rolls have 60% more capacity, they do better work, make better flour, better yield, flour more granular, they grind cool, the chop is mealy, and cool, and they take fully 50% less power, and it bolts very freely, assisting the reels or sifters to give more capacity.

Middlings going to rolls must be absolutely free from flour, dust, etc., as it retards the flow of the stock, it prevents correct feeding, also grinding, causes waste of stock, and loss of power.

If stock is being flaked it is caused by too much pressure and insufficient differential, and flaking is not necessary, in fact it is very detrimental to a close yield by pressing the flour onto the feed, and to remove it requires disintegrators, or brush bolters.

I well remember the old disintegrating centrifugals that came into use in the old world in order to combat the flakes, when it could have been prevented by giving differential and less pressure when grinding.

Roller mills ought to have self or ring oiling journals, or preferably ball bearings, and more will be said on this subject later.

The spreading or disengaging device should be arranged to throw out both sides of the rolls at one and the same time, and from either side of the roll.

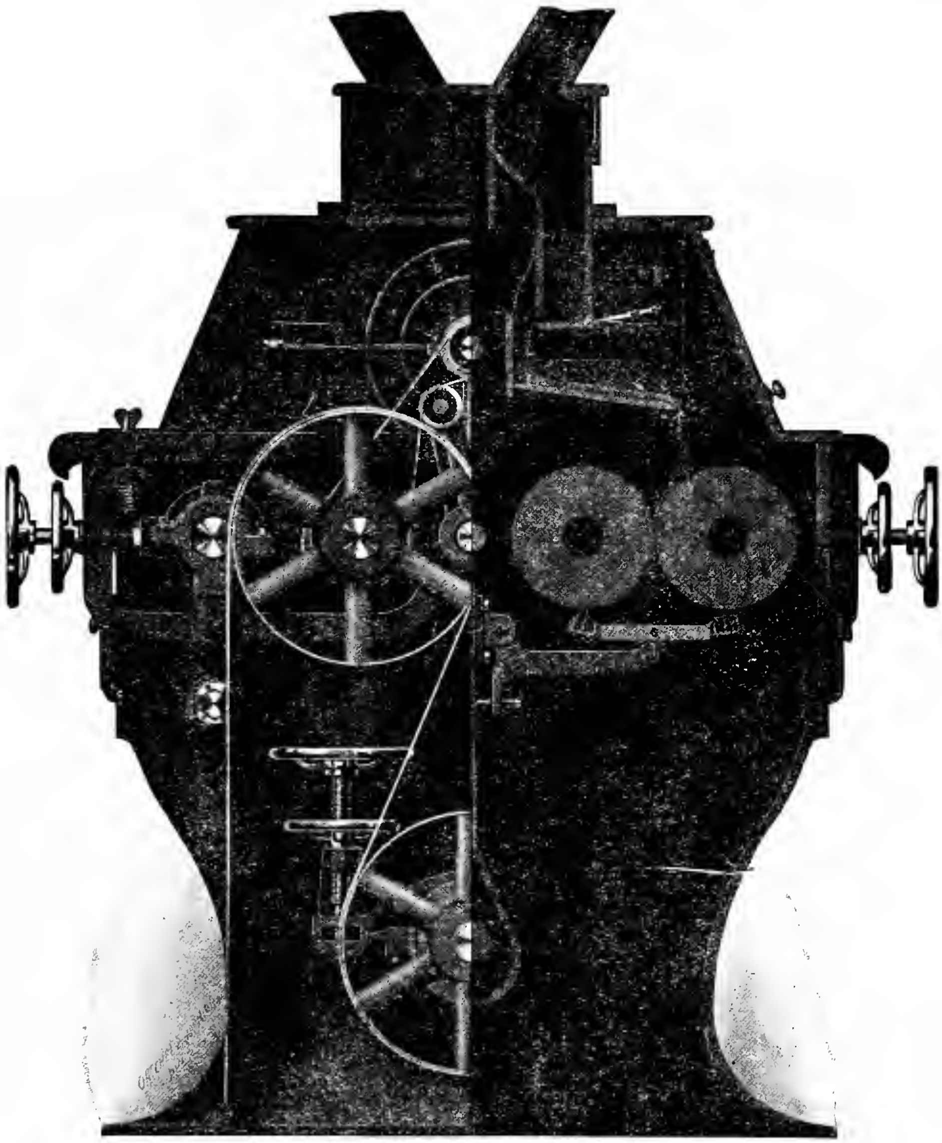
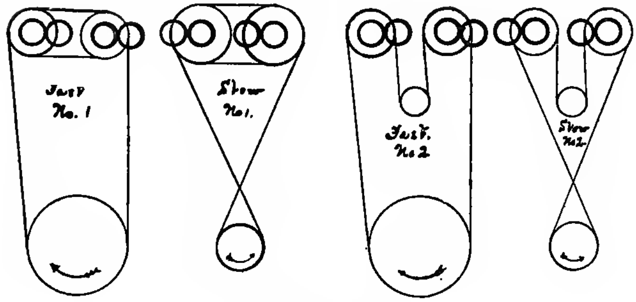


Fig. 9.

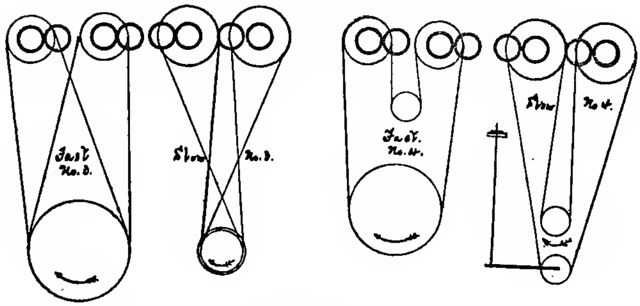
The roller type of feeder is preferable for all sharp stock, and having a spring attachment, and the roll scratched longitudinally in order to force anything larger than the stock it is feeding, or yet smaller than a grain of wheat, which can be removed by hand.

For soft stock and the break rolls stock the shaker feeder is preferred by the majority of operatives, and along the front there ought to be a strip cut with "V" shaped outlets, through which will pass the chop, and which assist in spreading the feed in an even and uniform sheet.

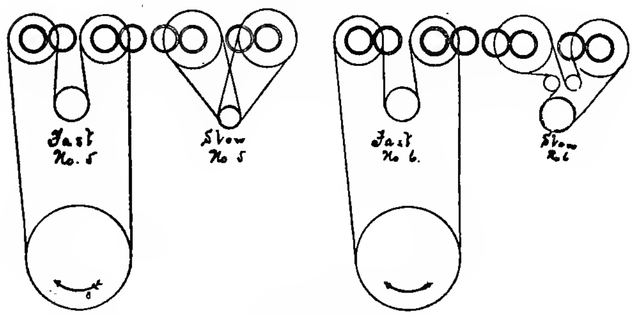
In softening or grinding middlings do not mash it into pulp, but rather leave it



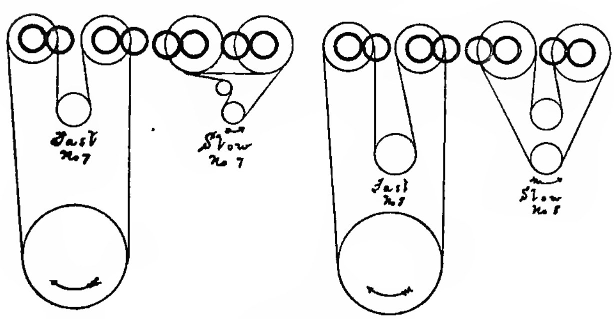
Group No. 1.



Group No. 2.



Group No. 3.



Group No. 4.

Roller Mill Drives. Fig. 10.

mealy, granular, yet smooth to the touch so that it will assist the bolting, and leave the flour in a lively, granular state, with the gluten containing its original strength.

The sizing of coarse middlings, and to do it correctly, is a fine art, and when done right, it will give the flour the slight yellow cast so much desired, and strength all bakers are looking for.

Coarse middlings ought to be sized and resized, bolted and rebolted, graded and regraded until there is nothing but the best flour extracted from them, and from sized middlings is obtained some of the finest and purest middlings in the process.

Our breaking, reduction, grading and purifying system is cut too short nowadays, and instead of shortening we ought to lengthen out so as to obtain correct separations.

The best smooth rolls for softening middlings are the porcelain, and which were used very extensively on the continent of Europe, and the United Kingdom where the roller process first came to light.

The chilled iron rolls are very good when they become frosted on their surface, when they will grind with little pressure.

Corrugated rolls on middlings do not need a greater differential than 2 to 1; and for sharp middlings on smooth rolls about 2 to 1; medium sized about 2½ to 1; and soft stock about 3 to 1; as the sharp stock requires more of a cracking motion, and the soft stock more of a grinding action.

Few millers stop to think that when the differential is increased the pressure needs to be decreased, therefore a saving in power is obvious.

On 1st sizing break or crack about ½ or 50%; on 2nd sizing break about three-fifths; on 3rd sizing about three-fourts; on 4th sizing break or crack about three-fourths. The object in all sizing is to get as many large, sharp, granular middlings as possible in order to purify them, and lengthen the purification of all the stock.

All belts must have flush or glued joints to do satisfactory work, save power and bearings, and to be almost noiseless.

Where rolls have the driving belts long or reaching to the line shaft or there about, they are more economical, require less tightening, less power, and less wear and tear of the bearings, and longer life to the belting.

In Fig. No. 10 is given a variety of drives which I consider the best in the belt driven type of roller mills, and these same were published in the March issue of the year 1912, of the dear old Dixie Miller, Nashville, Tenn., the original drawing by the author of this work.

Group No. 1 gives the drive belt within belt, or the short endless belt drive which dispenses with the idler, which is always beneficial in saving belting and power, and when properly stretched give little trouble.

In this drive there is very little friction, and the belts being endless or glued joints, it is very neat.

In Group No. 2 is given on the left of the group the drive which is the most economical of all the belt drives in my estimation, each roller mill having its own belt, and when once stretched it gives no trouble in belt tightening; and I once ran a double 9 x 24 smooth with this drive for five years, and for three years never remember touching a belt.

On the left of group No. 2 is the drive not to be admired, anyone may use it if they choose, but not your humble servant.

Group No. 3 is another one about the same type as the preceding, and not of my choice, but I suppose it has its advocates.

Group No. 4 is similar to the two preceding drives.

The main trouble with the roller drive with the driver running to the line shaft, and the slow side on the frame itself, is when the tightener tightens both sides at the self-same time, one of the belts suffer, and the bearings at the same time, and generally the slow, or short belt.

In cut No. 11 is given the drive of the Nordyke & Marmon Co. roller mill, which is an economical drive, and which gives little trouble with the belt on account of the length of the belts, and both being about of equal length.

Smooth roller mills require constant attention when in operation to see that every thing in connection with them is running as they ought to do, and always remember that there is only one way to run machinery and that is rightly.

When attending to rolls the operator ought to look over the grinding several times daily to be sure it is right, for great loss may be incurred by flour going to the feed bin.

To find speed of fast roll: Multiply revolutions of driving shaft by diameter of driving pulley, and divide by diameter of fast roll pulley.

To find speed of slow roll proceed in the same manner.

To get the differential, divide the fast roll speed by that of the slow roll, and the answer is the differential, or as follows:

Speed of fast roll 600, divided by 400 the speed of slow roll, makes the differential 1½ to 1.

This is when both belts run from the line shaft.

To get differential when running with idler:

Multiply speed by driving shaft, 200, by diameter of driving pulley, 30, and divide by diameter of fast roll pulley 15, which gives fast roll 400 revolutions per minute.

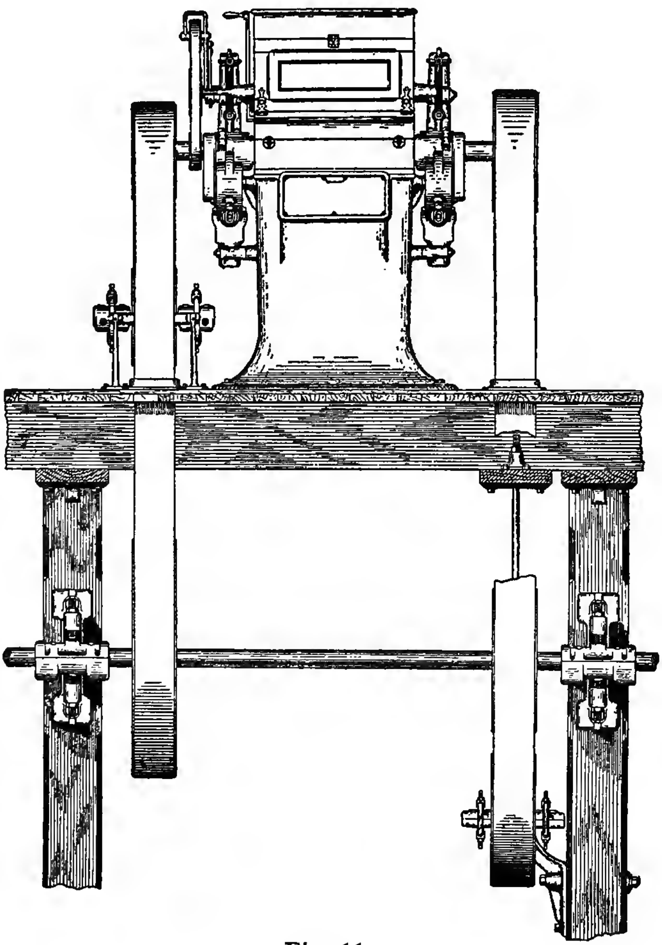


Fig. 11.

Multiply driving shaft 200, by diameter of driving pulley 30, and divide by diameter of driven pulley on idler 30, which gives idler shaft 200 revolutions per minute.

Multiply speed of idler shaft 200, by diameter of driving pulley on "slow roll side" idler shaft 10, and divide by diameter of slow roll pulley 30, and you have 66.66 or nearly 67 revolutions for slow roll.

Now divide fast roll, 400 revolutions, by slow roll, 67 revolutions, and you have almost 3 to 1 differential.

Chapter XIV.

BOLTERS AND BOLTING PROCESSES.

Bolting is very very important to good milling, and it takes an artist in his calling to do it according to the requirements of the close milling of today, and to give quantity and quality of products.

There are as many varieties of bolters as there are roller mills, and all are good when under the care of a competent miller, for there never was a scrub that could run a mill any better than a farmer, and no one should attempt to take charge of a mill until he is fully experienced.

On all coarse stock there is nothing superior to the sifter, and are the best of all for scalping and grading, and they employ almost every inch of the surface, while the reels use about one-third.

The sifter has a gentle action on the stock, it dresses the stock in a manner not possible with the bolters, the cloth is easily cleaned and kept clean, allowing the flour to pass regularly.

Beside the sifter we have the hexagon, round, force and centrifugal bolters and all have their advocates, and all are good in their place.

Of the sifters there are the Square, Plansifter, Universal, Wizzard, Peerless, Monarch, Unique, Great Western, Enterprise, Wolf, American, Gyrator, Swing, etc., all of them having their good points of recommending themselves to the millers.

Sifters have to be correctly balanced to insure correct running, and many are self-balancing which are preferable, providing the balance will balance, which in many cases has to be proven.

The driving belts should be endless, and just tight enough to insure against slipping, because they will not bolt unless they are up to speed which is about 180 revolutions per minute.

It requires a little over 1 H. P. for a sifter.

The greatest advantage of the sifter over the reel is in the fact of having separate sieves to interchange for the dressing of different wheats.

There is one advantage the reels have over the sifter, and that is being accessible at all times when anything occurs to the cloths, and the mill can often be run when a reel goes wrong, but not so with the sifter.

The sifter is divided into sections and runs on the gyratory motion, similar to that of the hand sieve.

The differential reel is very good for all kinds of stock, it has the gentlest action of all reels, taking the least power.

The reel has an outer cylinder clothed with cloth against which the bolting cloth rests.

The cylinder revolves at slow speed, and just inside the cloth revolves a series of blades at higher speed which keeps the stock against the cloth in a sort of spray, keeping the cloth covered.

There is a spiral to the blades which causes the stock to move towards the tail, and this spiral may be changed at will to suit the grade of stock and the feed.

There is a revolving brush on the outer side of the cylinder to keep the cloth clean.

The speed of the reel varies according to the diameter of the cylinder or barrel, and below I give the diameter and speed.

Reel diameter 16 inches, speed about 45, driving shaft 200.
Reel diameter 32 inches, speed about 30, driving shaft 160.

This reel takes about 3½ H. P. when loaded.

The round reel is good on all kinds of ground products, and for coarse products and minerals, it is of iron construction.

On the ribs there are spiral blades to cause the stock to travel from head to tail, the ribs, distributing the stock over the cloth.

On the outer side of the cylinder is a revolving brush to clean the cloth and keep the meshes open continually.

Diameter of reel 20 inches, speed 40 revolutions.
Diameter of reel 26 inches, speed 34 revolutions.
Diameter of reel 32 inches, speed 30 revolutions.

This reel takes about 1 H. P. when loaded.

The hexagon reel is somewhat similar to the round reel in speed, etc., but while the action of the stock on the round reel is a sliding motion remaining on the cloth until it reaches about one-third up the rising side when it commences to roll over.

The stock in the hexagon rises to about 50% of the elevation of the reel to which height it is carried by the rib, when it is thrown to the opposite side of the reel and almost at the bottom.

This reel has not the capacity of the round reel, yet it makes a more efficient scalper than the round reel.

Diameter of reel 18 inches, speed of reel 54.
Diameter of reel 22 inches, speed of reel 43.
Diameter of reel 28 inches, speed of reel 32.
Diameter of reel 32 inches, speed of reel 30.

This reel takes about 1 H. P.

Flour blending reel: This reel is very good, has large capacity, requiring about 1½ H. P. when carrying its usual load.

Wire or silk bolting cloth may be used on this reel.

Diameter of reel 16 inches, speed 52, shaft speed 250.
Diameter of reel 20 inches, speed 45, shaft speed 200.
Diameter of reel 26 inches, speed 34, shaft speed 155.
Diameter of reel 32 inches, speed 30, shaft speed 130.

Reels can be placed one above the other and be driven by a single belt to good advantage.

The centrifugal has similar action to the differential reel, and taking about the same amount of power, with capacity ranging from 20 to 50 barrels per hour, according to the size of the machine.

When bolting, there are two things, required, the one a good slick or spatula, and a smooth paddle about three inches wide; from the reels or sifters take the flour and slick it in the dry, then slick it for dipping for color, and the detection of specks.

Specks at the head or down to the fifth middlings in about a five break mill will not injure the flour like the tail of the mill speck; those at the head being mostly balls of flour, while those at the tail are the worst of impurities, which discolor the flour.

When sending middlings to rolls or purifiers be very careful to have them free from dust, or correct grinding or purifying is impossible, with waste in power, and sluggish flour.

Never cut backward on reels, but cutting forward is essential to good milling, and all undusted stock should be sent to other bolters.

Always bear in mind when bolting, that the sooner the flour reaches the packer after it is flour the better flour it will be, and get the flour unmauled into the sack, for every time it is cut to another machine, it deteriorates in value.

Before cutting a slide to flour, put some on the paddle and slick it down and examine with great care for the detection of the objectionable specks, which a competent miller will generally detect at a glance.

The cloths should not have a very wide range for flour, or uniformity is not possible, the following being about right:

For patent Nos. 11, 12 and 13; for straight Nos. 11 to 14; clears on Nos. 12 to 15; low grades Nos. 10 to 14, according to the requirements of the mill making it; red dog Nos. 9 to 11.

To bolt on the foregoing numbers the flour will be clear and uniform; but when patent is bolted on Nos. 9 to 15; and straight on the same numbers, it makes the flour very irregular.

When the reels are making too many specks, or the sifters either, grind closer to make the stock more floury, which will warm up the bolting cloth, thereby closing the meshes by expansion.

Be sure to have all cloth cleaning devices doing their work efficiently in order to get capacity, and uniformity of products.

It is good policy to go over the reels and sifters with a good hand brush whenever possible, for it removes the granules that are lodged in the meshes which the travelling brushes will not remove.

Keep samples of flour to mill by, for comparison at all times is necessary, for no man can rely upon his own judgment.

Samples placed in the sun will bleach out in a day, and samples a week old are of little account to compare against unless they have been kept in a dark box, for light and heat bleaches it.

Cutting specky flour from one reel to another should be sent to the reel nearer the tail, and floury middlings to the same place, or to reel working on similar stock in color, cutting clear or pure flour to packer, and clear sharp middlings to rolls or purifiers, which are the all important features of correct bolting.

All reel and sifter bolting cloth ought to be put on just tight enough to not sag, yet not too tight to break to get the best results.

Speeds and all particulars may be secured from the catalogs of the mill furnishers, as it would be out of place here, and I am only imparting the knowledge absolutely necessary for the miller to know in order to do good milling.

In cut or figure No. 12 is given the correct and incorrect method of clothing a reel, and it is necessary to clothe it right to give capacity.

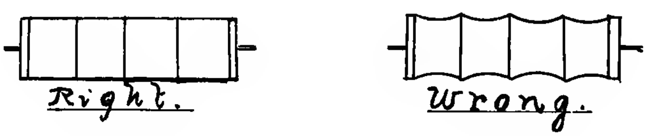


Fig. 12.

By getting the flour to the packer as soon as it is flour, it imparts a creamy tint, slightly white, is granular, lively, and full of bloom.

Do not squeeze the germ middlings too severely or a deep yellow tint will be imparted to the flour, giving it the appearance of flour from Duram wheat.

There are many different drives for reels, and in cut No. 13 is given the most commonly used today.

A redresser is a good arrangement to catch the specks should a reel burst, and not be noticed before many barrels of flour had been contaminated, as was the case in a car of flour it was my good fortune to go to Baltimore to inspect.

The motto here is: grind to bolt, and bolt to grind.

Dressers, scalpers and purifiers should be looked over at least weekly, as the

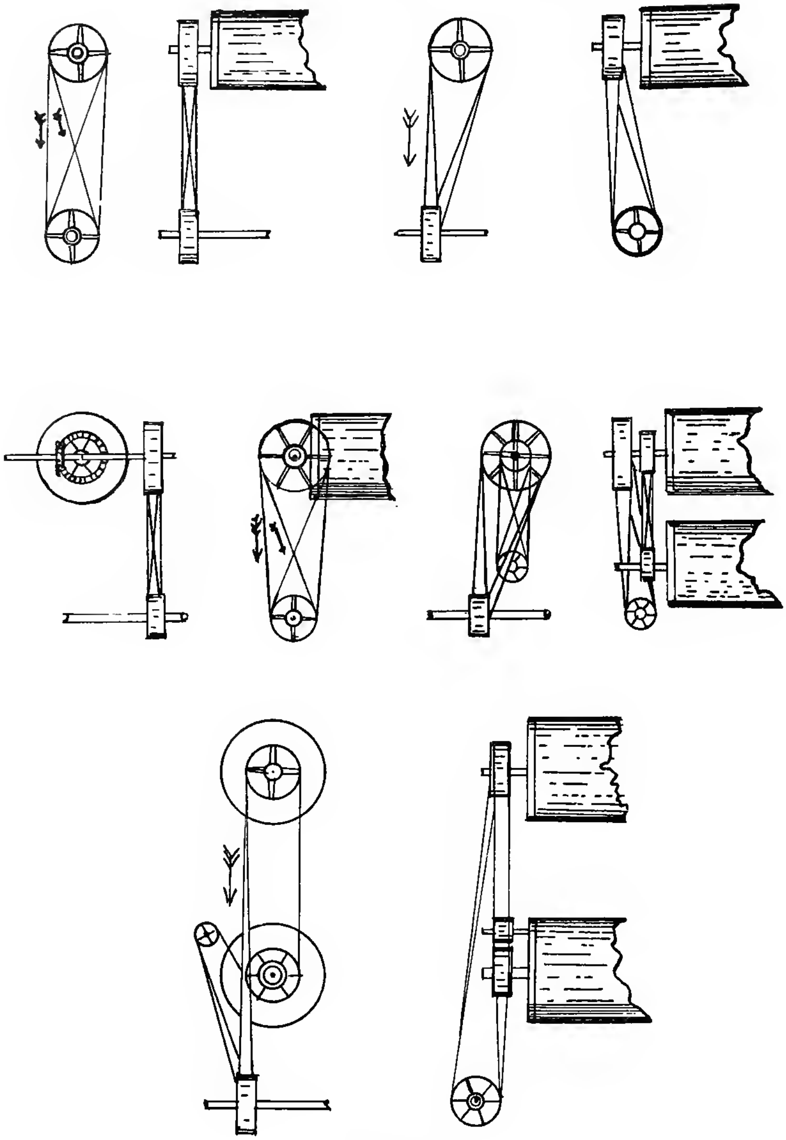


Fig. 13.

cloths are apt, at any moment, to become perforated with small holes larger than the meshes, which will cause much trouble.

Patching holes of all descriptions requires skill and good judgment, as they require to be done neatly, and at the same time effectually.

Make the patches just large enough to withstand the pressure from the stock and the air from the inside of a reel.

Centrifugals require a little larger patch than a reel, as there is much more pressure to the square inch from the beaters.

When patching a quarter inch hole do not put on a patch large enough for a two-inch hole. The writer has frequently seen this done. Bear in mind that every mesh closed unnecessarily removes a mesh of the bolting surface. Some will say that

this matters little, it is such a small thing. True, it is a small thing, but it is the innumerable small things which constitute the whole. For a quarter-inch hole put on a neat, square patch of half an inch square; for a one-inch hole, a patch of two inches is necessary, as the pressure from the inside is much greater in proportion.

In mills of 400 barrels capacity, and over, it is expensive to close down; and it frequently happens that the reel cloths have holes torn in them large enough to get through. It is then found necessary to take some stitches, and put on a large patch of muslin, with raw paste, never boiled. The mill being in operation it is not possible to do a perfect piece of work. The size of the patch must be decided by the judgment of the operator.

Do not try to stop any but pin-head holes with paste. When this is done it should be just touched with a pointed stick, with paste stiff enough not to run. Liquid glue is good for this purpose.

It is the same with patching as with other work, if it is worth doing at all it is worth doing well, as bolting cloth is very expensive. When buying this article, buy the best quality, and of a reputable house.

Purifier cloths must be put on without a crease or ruffle, and all ought to have a tightener attachment, applicable when the machine is in motion. Also an adjustable traveling brush, or cleaner. Otherwise the middlings will be very irregular in size, and impure.

When clothing round reels, or centrifugals, put the cloth around and fasten loosely; tack around the head first. Some machines have an iron band, which is very good. Tack as straight as possible, drawing the ticking just tight enough not to pucker. It must be watched very closely during the operation, for it will get out of line. Now, proceed to the tail, and take the center of the sheet, stretch lengthwise until every crease is out, and tack to each corner. Then sew lengthwise, but not too tight, or the cloth will sag between the hoops.

Cover the sewing with a neat bandage just of sufficient width to cover the ticking, as it frequently happens that the silk gives way where it is stitched to the ticking, resulting in specky flour, and the rent being obscured, it is often not discovered until much contaminated flour has been packed.

The work of a straight cloth is always superior to that of a loose, sagging one, and it requires great pains to put on a cloth as it ought to be, for it dresses better, has more capacity, the flour is more uniform, is relieved of its load more expeditiously, and saves power.

It is not possible at all times to put on a cloth perfectly straight, for the cloth is not always made as it should be, and the cylinder is often at fault, but when it is perfectly straight and tight it is an easy matter to keep it clean, the brushes working as near perfection as possible.

It is not always an easy task to put on a cloth perfectly straight on account of the formation of the encircling hoops, and the stretching circumferentially must be done right at the hoops.

Chapter XV.

FLOUR AND FLOUR TESTING.

The varieties of flour are almost without number, and in as many different countries pass under as many different names.

High or short patent is up to 40% of the wheat contents of flour, or as they say in every-day parlance 60% patent, so I will name them in the latter phrase:

Medium or standard patent is up to 90%; long patent up to 95%, which is really a full straight; full straight is every thing the wheat contains in flour, less about 2% of low grade; cut straight is when patent has been taken off at the head of mill; fancy clear is what remains after taking off 60% patent; 1st or standard clear is the remains after taking off 70 to 85% of patent; 2nd clear is after 85 to 90% of patent has been taken off; cut straight is often spoken of as very fancy clear or bakers; low grade is what remains after taking off 97 to 98% of straight; red dog is the bran and shorts dustings.

The wheat berry contains approximately 84% of flour if it could be extracted to the last speck, but so far that has not been possible, and to my idea it never will, but there will come a day when there will be a great deal more taken out of the wheat than at present.

At the present day milling the percentage of flour being extracted is from about 65% to 76%, including low grade when it is being bolted through Nos. 14 and 15 cloth and can really be called flour.

The testing of flour by headmillers of today is a very important factor in the production of flour that is satisfactory to buyers of discrimination, and it is very important that they keep themselves up to date in this respect.

Every headmiller ought to have a set of testing sieves in order to be sure at all times when his flour is pure, and when changes may be made beneficial to the business.

It keeps a headmiller on the alert to see that the wheat being sent to the mill is sound in quality, for no amount of cleaning and scouring will make unsound wheat make sound flour.

Headmillers, grinders, bolters and purifier tenders ought at all times to carry a good flour slick or spatula of at least 2½ inches in width, for it is needed at any moment when the millers are going their rounds, and to place the flour to be inspected for specks on to the trying tablet, to be slicked down and inspected near the light.

A tablet and three or four narrow strips of board about 1½ x 6 inches long are necessary to use for dipping the flour for specks and color.

When preparing samples for dipping or comparison, take the narrow board, place thereon a small amount of flour, slick it with not too much pressure, cut it off at each side leaving about an inch, slant the board and that which has been cut off will slide off; now place more of another grade on the board away from that which has been slicked, slick it, cut it off, let the loose slide off, push that which has been slicked along to the first that was placed there, now slick the two together, and so on with several samples.

After you have all of them slicked on the board and cut off, you may examine them in the dry, and then dip them into very clean water for about thirty seconds, and should it blister when drawn out, immerse it again and they will disappear, and after dipping, place them in a place to dry, when you may see the changes in color taking place while passing through the drying process.

You may place several different flours on the dipping tablet at one time, and see the lines of color between each sample.

Specks may be detected by a magnifying glass to good advantage, but the specks

at the head of the mill are not so injurious as the tail of the mill specks for the reason that those at the head of the mill are balls of flour, while those at the tail are all feed.

After the flour is dipped into the water after being slicked on the lath, the flours will change in color, each taking a different color, some white, yellow, creamy, gray, blue and dark.

When slicking the flour onto the lath have it about one-eighth of an inch thick, for to have it too thin will make the wood give the flour a dark appearance.

To dough for strength: Take a handful of flour, make a hole in the center, fill the hole with water, or just enough to make a stiff dough; for winter wheat flour, and a soft, loose dough for spring or hard Kansas, mix it with the finger or match stick until it is into dough, then knead it with clean fingers until it is smooth, pull it, knead it, stretch it, knead it several times, stretch it out like a sheet of paper, and if it will not break easily it has strength, but should it break off short it lacks strength.

Many samples may be tested at the same time, by kneading first one and then the other, and after pulling and kneading them for strength, place the doughs side by side in a clean place where there is little dust, and watch their color, for there will be many changes while they are passing through the drying process.

Creamy white tinted flour is preferred at all times; an orange tint is good; white is alright, but gray and blue tinted flour is objectionable.

For an accurate test of water absorption it is necessary to have scales, and weigh all the ingredients, and the flour taking the most water is generally the strongest, and it is the most profitable, and especially to the baker, who sells moisture.

Washing for gluten: Weigh two or three ounces of flour, mix water enough to make the dough just right for kneading, weigh the dough for water absorption; now place this dough in a piece of very fine bolting cloth, or fine muslin, hold it under a faucet with water running onto the same and kneading it at the same time, continue this until the water passing from it is perfectly clear, this showing the elimination of all starch, clean all the gluten off of the cloth after all the moisture possible has been squeezed out of it, weigh this mass for the starch which has been washed out ofit, then weigh this same mass for the wet gluten, place the wet gluten in an oven at 130 degrees fahrenheit until it is dry, then weigh it for dry gluten test.

To test for moisture content of flour: Weigh one to five ounces of flour; place it in an oven with about 205 degrees fahrenheit for seven to eight hours, then weigh and note the change, which ought to be about 13%, which is the average moisture content of flour.

Do not allow the flour to stand after taking it from the oven before weighing, for it gathers moisture very quickly after being removed from the oven.

The baking test: Dissolve one-half cake yeast with one tablespoonful sugar in one pint lukewarm water, let it stand ten minutes; add one tablespoonful melted lard or butter, and two pints of flour, beat until smooth, add one pint more flour, or enough to make a loose dough for spring or Kansas; and stiff dough for soft winter, add one heaping teaspoonful of salt.

Knead this until smooth and elastic, place in greased bowl and set aside under 85 degrees fahrenheit free from drafts, for about two hours, or until light.

Mold into loaves, place in well greased pans, filling them about half, cover and let rise until doubled in size under 85 degrees fahrenheit, place in oven at about 480 degrees fahreheit and gradually falling to 450 fahrenheit, baking thirty-eight to fifty-five miuutes, according to size of loaf.

This is a quick method for testing, and the ingredients are:

½ to 1 cake yeast;
1 pint water,
1 tablespoonful sugar,
1 tablespoonful melted lard or butter,
3 pints warm, sifted flour,
1 heaping spoonful salt.

THE SPONGE OR SLOWER METHOD.

Dissolve ½ to 1 cake yeast together with 1 tablespoonful sugar, in 1 pint lukewarm water, add 2½ pints flour, beat it well, cover it, place in warm place 85 degrees fahrenheit for about ninety minutes until well risen; now add ½ pint more water, lukewarm, 1 spoonful "table" melted butter or lard, 2 pints flour, or just enough to make firm dough for winter, loose for spring or Kansas, 1 heaping teaspoonful salt, knead it well, put in greased bowl, cover and place in warm room 85 degrees fahrenheit for two hours, or until light and elastic, mold into scaled loaves for quantity, place in greased pans, place in warm place for about an hour, or until doubled in size. Place in oven at 500 degrees fahrenheit, dropping to 450 while baking, forty to fifty minutes. Scale loaves 17½ pounds, bread will be just about 16 ounces baked; measure the loaf for expansion; weigh the flour and get the absorption.

Ingredients:

½ to 1 cake yeast,
1½ pint lukewarm water,
1 tablespoonful sugar,
4½ pints of flour,
1 tablespoonful melted lard,
1 heaping spoonful salt.

The ingredients for a miller's test:

340 grams flour,
15 grams sugar,
10 grams yeast,
5 grams lard,
5 grams salt,
236 grams water.

To the lukewarm water add the sugar and yeast, stir and let stand ten minutes; put in the melted lard or butter, and about half the flour, mix until a batter, smooth, put in the balance of flour, and rest of water or enough to make a firm dough.

Now knead until smooth and elastic, place in greased bowl, set it to rise under 85 degrees fahrenheit from 1½ to 2 hours, mold into scaled loaf, put in greased pan about half filled, let rise under 85 degrees fahrenheit for forty-five to fifty-five minutes or until about doubled in size, bake from forty to fifty-five minutes in oven at 450 degrees fahrenheit falling to 400 degrees fahrenheit as baking.

Weigh all the ingredients.

Weigh the flour before adding ingredients.

Weigh the dough after all ingredients are added.

Weigh the bread after baking for quantity and gain.

Take the amount of loss from going to oven to coming out.

I give below a test sent me by The Russell-Miller Milling Co. and I publish it on account of my acquaintance with Mr. Miller for so many years:

Ingredients:

49 lbs.	oz.	flour.
23 lbs.	oz.	water.
8 lbs.	oz.	milk, fresh.
1 lb.	2 oz.	sugar.
1 lb.	4 oz.	lard, pure.
	15 oz.	salt.

Amount of material, 83 lbs. 13 oz.

Dough made at 7 a. m. went to bench 11:15 a. m. Proofed 30 minutes; panned at 11:50. In oven 12:25. Temperature 505 Fahr. Out of oven 1:10 p. m. Temperature 410 Fahr. Total dough 83 lbs. Total bread 73 lbs. 8 oz. Visible loss 10 lbs. 7 oz. Absorption 63%. Loaves scaled 17½ oz. Bread 16 oz. Total loaves to the batch 74.

Testing flour for ash. The ash content of flour is the incombustible part. Wheat contains approximately from 1.55 to 2.2 per cent. of ash, the average being about 1.70 per cent.

Ash content of patent flour is about ....50 per cent.
Ash content of straight flour is about .... .65 per cent.
Ash content of clear flour is about .... .80 per cent.
Ash content of low grade flour is about ....1.05 per cent.
Ash content of red dog flour is about ....3.02 per cent.

To obtain the ash of any of these products it must be burned in an electric furnace so that the ash will remain intact in order to weigh it accurately. Ash is mostly the impurities coming from the outer coatings, so that the longer the patents the more ash it contains.

Gluten content of flour. Dry gluten varies from about 6 to 17 per cent., the average being about 12 per cent.

To obtain the wet gluten multiply the dry gluten by three.

The average dry gluten in spring patent is about 10 per cent.

The average dry gluten in spring straight is about 12.5 per cent.

The average dry gluten in spring clear is about 14 per cent.

Kansas hard turkey patents have about the same average.

Soft winters about 3 per cent less for the averages.

The gluten exists in very minute particles, and it is insoluble in water, glycerine or alcohol, and are not affected by Iodine.

Gluten is a nitrogeneous substance or composition, tough and elastic, and without it in flour a light loaf of bread would be an impossibility.

Under nitrogeneous compositions there are four proteins in the wheat berry, namely, edestin, lencosin, gliadin, and glutenin; and gluten is composed mostly of gliadin and glutenin.

The flour containing the most gluten of a high class is the best for bread making purposes, yet the higher the patent the least amount of gluten it contains, but the gluten in the patent is superior to that in the lower grades of flour, and the reason for this lies in the fact of being taken with less milling or the killing of the gluten by excessive pressure, etc.

Spring and hard Kansas flours are the best for bread making purposes on account of high gluten and low starch content; while the soft winter is the best for pastry for high starch and low gluten content.

Flour contains from 40 to 60 per cent. of starch, starch is a vegetable matter, and contains carbon, oxygen, nitrogen, and a little mineral matter.

Starch cells when heated will expand and absorb water, and to stand up must have the support of the tenacious gluten, and being raised by the carbonic acid gas bubbles become stiff or solid by the intense heat of the oven, giving the loaf backbone.

Ropy bread is very annoying to a miller or baker, and has caused the small millers much trouble for the reason that they were unable to combat the evil, and what caused it.

Rope developes in the hot season, and the most favorable temperature to its development is 103 degrees Fahr., the bacteria developing rapidly under this temperature and not so rapidly under less degrees of heat.

The germ causing rope belongs to the class causing viscus fermentation, and it is assisted in its work by uncleanliness in bakeshops.

Improper storing of flour is the cause sometimes for rope, dampness and then warmth is favorable to ropiness, and flour should be stored in a cool and dry warehouse.

Ropy bread can scarcely be detected until the 2nd or 3rd day.

To see rope in bread is the most disgusting thing imaginable to baker or miller, and rope is not known by all millers and bakers.

Rope is like unbaked dough, and will pull in strings when the loaf is torn apart, and in time has a very objectionable odor.

Every utensil in the bake shop must be scalded, the shop must be aired as much as possible and kept very dry, dry lime dust spread in every crevice of the walls, floors, etc.

Take the utensils into the open air after cleaning as much as possible, and scald as often as possible with boiling water, and a good plan is to burn a formaldehyde candle as a fumigant in the shop when it is closed for some hours.

It is very difficult to prescribe a general remedy for the reason that there exists a difference in the germs, and the germs may be of the first or second generation.

CHAPTER XVI.

FLOW SHEETS.

The flow sheet or diagram is the mill's modus operandi; it shows to a miller the run of his stock from its entrance into the mill as wheat until it is a finished product ready for the market. Making a correct flow for a mill of any size is no easy task. Probably there are no two mill furnishers in the United States or Europe that would give the same flow for a mill of equal capacity.

Herewith are given several flow sheets or diagrams that the writer believes to be as nearly perfect as possible for the stated capacities. He has planned, diagrammed, remodeled, and built many mills, and the flows here given are the results of the experience thus obtained. They combine large yields with the best flour, economy of operation, simplicity of construction, and the minimum of repairs. Unfortunately, as much cannot be said of some of the mills built or remodeled by milling doctors. Frequently they do not understand what the miller needs. After the order is obtained the requirements are merely scanned and not studied so as to give a simple, economical, and an effective mill. In such hasty and imperfect plans, conveyors, countershafts,

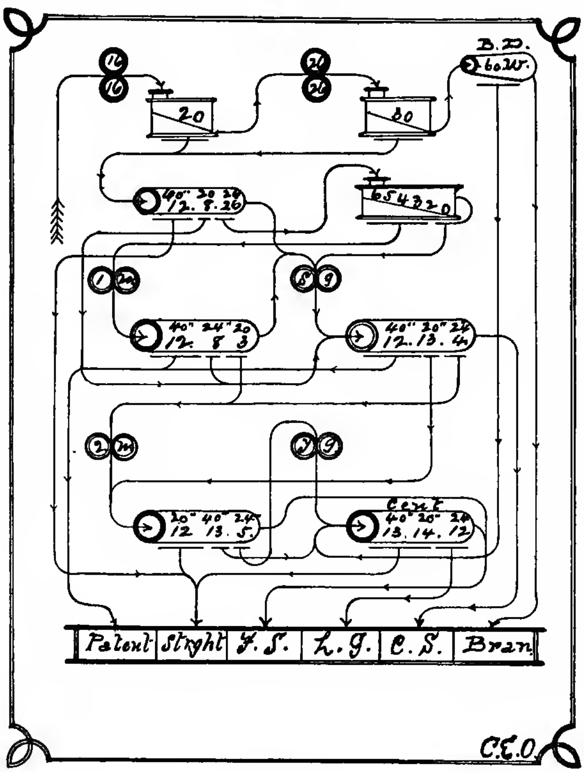


Fig. 14.

and no end of extras figure up a big bill, and after the mill is built and accepted, possibly it must be rediagrammed before it is of any use for the purpose intended.

Fig. 14 presents a good flow for a 25 to 30 barrel mill grinding steamed hard or unsteamed soft winter wheat. The cleaners that may be used for this flow are a separator and a separator and scourer combined, or two machines of the latter type, omitting the former; or one combined separator and scourer will do the work by running the wheat through it twice.

The rolls shown are all 6 by 12.

The first break runs with a differential of 2½ to 1, has 16 cuts per inch and breaks about three-fourths, taking out about 80 per cent. of the middlings.

The second break or bran rolls run with a differential of 3 to 1, have 26 cuts per inch, and must not run close enough to cut the bran in shreds and small particles, but to leave the imprint of corrugations in the bran.

The scalpers are No. 1 standard of one sieve each. If you are using hexagon

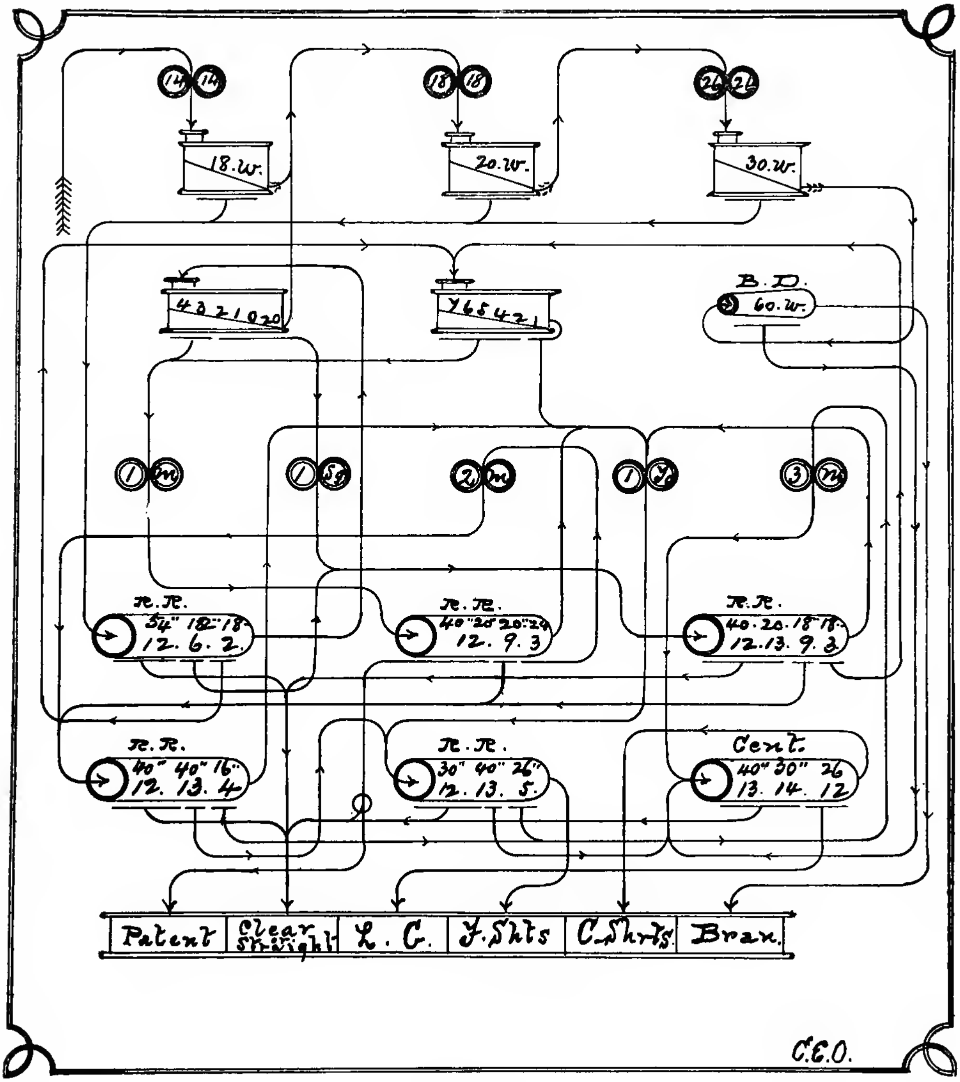


Fig. 15.

or round reel scalpers, clothe the head half of the first reel with No. 30 wire and send to reel No. 1; clothe the tail sheet with No. 22 and send to purifier. Clothe the head sheet of second reel with No. 36 wire and send to reel No. 1; the tail sheet with No. 30 and send to No. 2 rolls.

The scalpers are clothed with wire.

The reels are all 16 inches by 7 feet and run at 54 revolutions per minute, and are clothed with XX Swiss silk.

The purifier is a Geo. T. Smith No. 0, having a strong blast.

The first smooth rolls run with a differential of 2 to 1; the second with a differential of 2½ to 1, the third, 3 to 1 and the fourth 3 to 1.

The centrifugal may be clothed its entire length with Nos. 13 and 14, sending all the flour to straight.

A mill thus planned will make a barrel of flour out of four bushels and 40 to 50 pounds of good wheat of 58 to 60 pound test, and the flour will bake a very light, firm and creamy loaf that will give entire satisfaction.

Of course the middlings must be softened but not mashed.

It is a two-break mill, and good judgment must be used to get all the middlings from first break, and at the same time leave the stock as near to bran as possible.

Fig. 15 shows a 35 to 50 barrel three-break and five reduction flow. It will give from 20 to 30 per cent. patent; 65 to 75 per cent. straight, or clear; and 5 per cent. low grade, or 100 per cent. straight. It will make a loaf of bread equal to any winter wheat flour. It is for grinding either steamed or dampened hard or unsteamed soft winter wheat.

The cleaners should be one separator, and two combined separators and scourers, with magnetic attachment.

The first break has 14 cuts, and a differential of 2 to 1. The rolls are 6 inches by 12 inches, the same as the rest of the rolls shown with the exception of the second break and No. 1 smooth rolls, which are 6 x 15. Grind for about 60 per cent, middlings.

The second break has 18 cuts and a differential of 2½ to 1. Grind for the rest of the middlings but get them as large as possible.

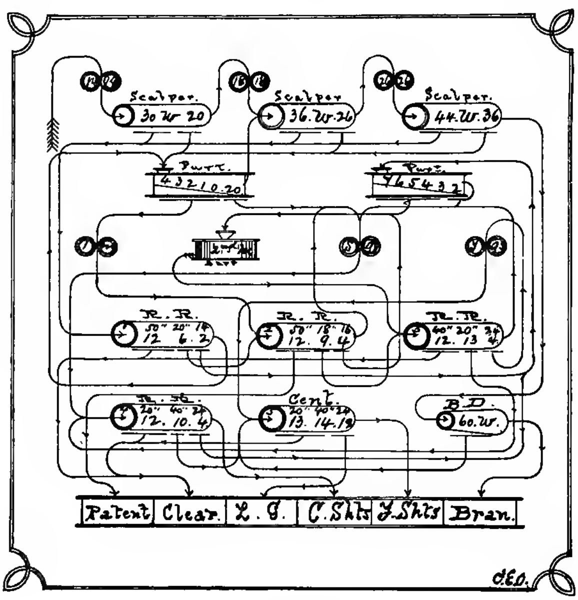


Fig. 16.

The bran roll has 26 cuts per inch, a differential of 3 to 1, and is 6 by 12. Grind clean, but not to chip the bran; for when it is clean, that is all that is required.

Rolls ought never to travel more than 1200 feet per minute, and 1000 feet for the fast roll is high enough speed.

The scalpers are No. 2 of the standard type, having one sieve each and wire cloths.

If you are using hexagon or round reel scalpers and wish to put in this flow, clothe head of first with No. 30, second with No. 36 and third with No. 44 and send all siftings to No. 1 reel.

Have tail sheet of first clothed with No. 20, second with No. 26 and send the siftings to first purifier. Clothe the tail sheet of third reel with No. 40 and send siftings to No. 4 rolls.

The purifiers are Geo. T. Smith No. 0 machines.

The reels are 22 inches by 8 feet and run 40 to 45 revolutions or about 220 feet per minute. They are clothed with XX Swiss silk.

The lines beneath each machine and on each diagram will indicate about the quantity to draw on each machine.

Fig. 16 gives a combination flow of a 50 to 60 barrel mill, grinding steamed or dampened hard or unsteamed medium winter wheat, and using three breaks. The system is short, and the flour must be put in sack at the beginning. Patent, clear, or low grade may be made, but a good straight is preferable with this flow.

The first break has 14 cuts per inch, with a differential of 2 to 1, and the rolls are 7 by 14. Grind as in the previous flow, for about two-thirds middlings.

The second break has 18 cuts per inch, runs with a differential of 2½ to 1, and the rolls are 7 by 18. Grind light, removing the rest of the middlings in a sharp state, and with but little break flour.

The third break has 26 cuts per inch, with a differential of 3 to 1, and its rolls are 7 by 14. It should be run to clean the bran only, and not to cut it.

The first middlings rolls on No. 1 middlings are 7 by 18. Send all the middlings that are clean from the first purifier to them, and keep an even feed for the burr.

The burr is 36 inches in diameter and runs 300 revolutions. Soften the middlings just enough to make them smooth, loose, and just warm. The middlings going to it must be pure and fine. When you have burrs, they may be used to good advantage in a roller mill, but only on pure middlings. They must be kept in good condition, with face and furrows smooth. Have the face of the upper runner slightly hollowed from skirt to the eye and it will run very cool.

Fig. 17 gives the flow of a 100 to 130 barrel combination mill grinding seasoned winter wheat. It will make about 30 per cent. patent, 65 per cent. clear, which may be sold as a straight, and 5 per cent. low grade. Or, it may be all run into one packer and made a fine article of straight flour. In a mill of this kind, three pairs of burrs ought to be used so that one may be idle, in order to avoid having to stop the mill for the purpose of dressing stone.

The first break is 9 x 18, has 12 cuts per inch, a differential of 2 to 1, and makes about 30 per cent. of the middlings which are very large and clear.

The second break is 9 by 24, has 14 cuts per inch, a differential of 2½ to 1, and makes about 30 per cent. of middlings of about 00 size, which are white and sharp.

The third break is 9 by 24, has 18 cuts per inch, and runs 2½ to 1. It makes about 20 per cent. of the middlings of, say No. 1 size, and they are white and sharp.

The fourth break or bran rolls are 9 by 18, have 26 cuts per inch, and run at a differential of 3 to 1. They make about 5 per cent. of middlings of about No. 4 size. They are not clear, but by being put on a finely clothed purifier with a steady current of air they may be made nearly pure.

The scalpers are two-sieve standard style, No. 5, and clothed with wire of numbers indicated on the flow.

The purifiers are Geo. T. Smith machines, using a Cyclone dust collector on each one or still better, a large Perfection for all. The reason for preference is that

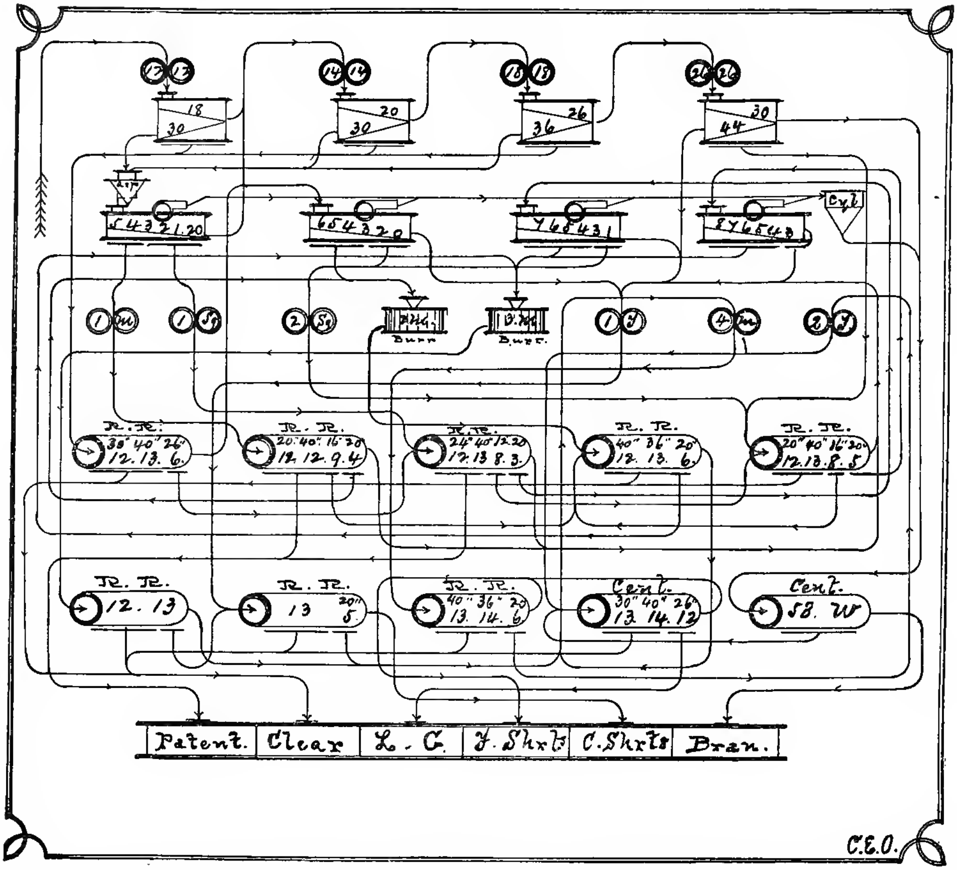


Fig. 17.

a strong current of air is always available in removing impurities and dust, and at the same time there is no waste, as it returns the material to the flour and offals, or just where it belongs.

There are 8 round reels and two centrifugals, one of the latter as a bran cleaner, and the other as a finisher.

One aspirator is used on the germ middlings.

The burrs are 42 inches in diameter, speed 240 revolutions.

All the smooth rolls are 9 x 18, No. 1 runs with a differential of 2 to 1; Nos. 2, 3 and 6 run with a differential of 2½ to 1, and Nos. 7 and 8 with differential of 3 to 1.

Fig. 18 gives a flow which is really first-class, as the size of the mill permits of good separation, and keeping the stock going to the rolls at about equal granulation for each grade.

The first break has 12 cuts; its rolls are 9 by 18, and have a differential of 2 to 1. It grinds to remove about 30 per cent. of the middlings, say of a size No. 18 or 20, sharp and clear.

The second break has 14 cuts per inch; the rolls are 9 by 24, and have a differential of 2½ to 1. This break removes about 30 per cent. of the middlings of say No. 20 to No. 26, which are sharp and clear. Always have the break stock feeling and appearing sharp and lively, but never mashed or mushy.

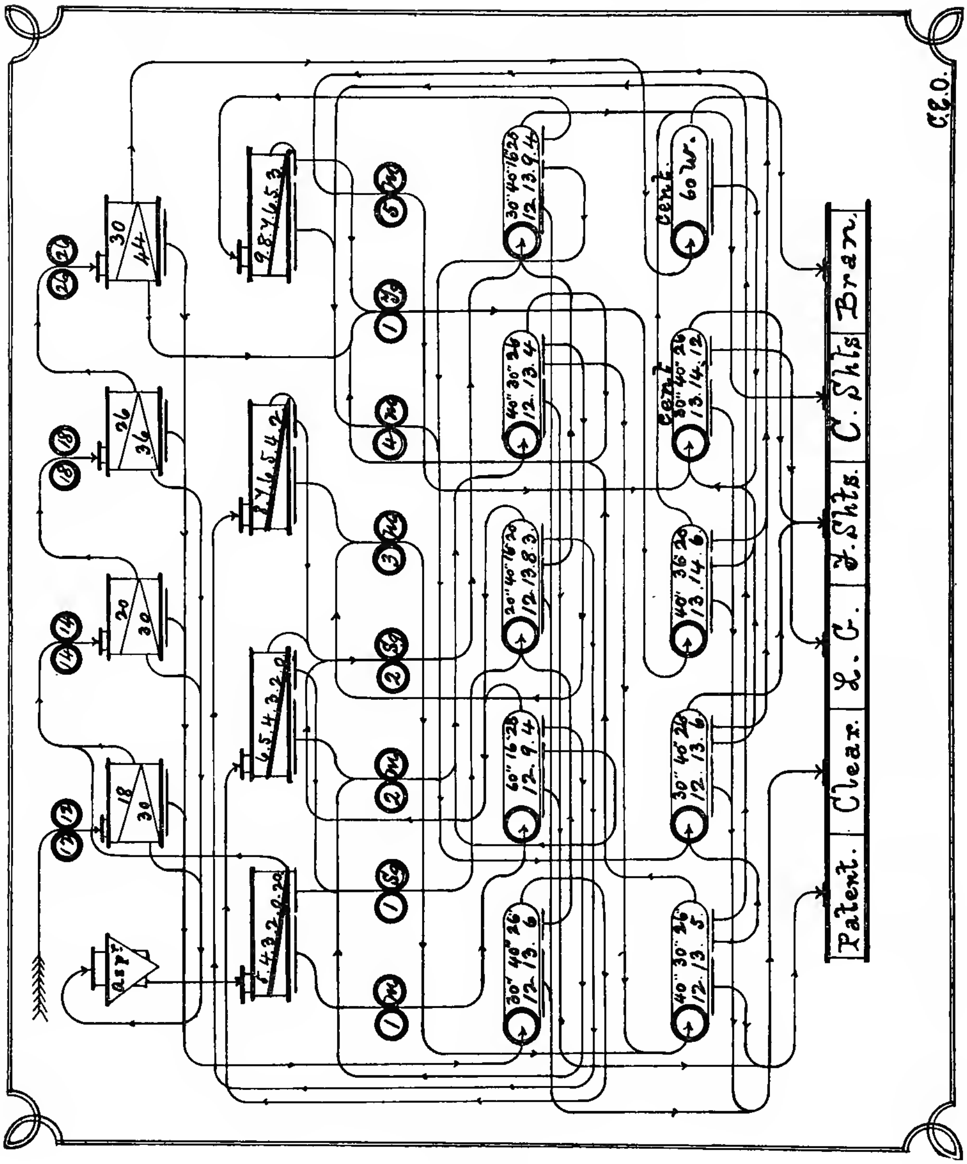


Fig. 18.

The third break has 18 cuts per inch; its rolls are 9 by 24 and they run at a differential of 2½ to 1. This break to remove about 20 per cent. of say No. 26 middlings, clear and white after purification.

The fourth break or bran roll has 26 cuts per inch; the rolls are 9 by 18 and run at a differential of 3 to 1. This break removes the rest of the middlings which are very fine and also the rest of the break flour.

There is one aspirator in this flow to work on the germ middlings.

Size on No. 2 rolls very gently and only crack the middlings and you will get a very fine article of No. 2 middlings from them.

The No. 4 rolls act as a sizing roll, and grind enough to clean the coarse shorts.

No. 3 and No. 5 rolls are 9 by 24 in size; the rest are 9 by 18.

The differentials are, Nos. 1 and 2, 2 to 1; Nos. 3 and 4, 2 to 1; Nos. 7 and 8, 3 to 1; Nos. 5 and 6, 2½ to 1. All are round reels with the exception of Nos. 9 and 10 which are centrifugals.

The cleaners to use for the flows shown in Figs. 19 and 20 are for very dirty wheat without cockle, warehouse separator, milling separator, two scourers, or one scourer and one brush, and a wheat steamer and dampening arrangement. If the wheat is fairly clean, one separator is sufficient. It is a good plan to have separators on the scourers also.

The purifiers are Geo. T. Smith No. 1, or any of equal capacity.

The reels are round, 32 inches by 8 feet, running 30 revolutions.

This flow is for steamed hard or medium unsteamed winter wheat. It will make 130 barrels per day when well handled. The writer has operated this flow, except that the machines were of different construction and using hexagon scalpers; and it held its own against all competitors.

In none of the foregoing flows should the stock be treated severely, as it is not necessary.

Fig. 19 shows the flow of a five-break and nine reduction mill grinding seasoned winter wheat and making 60 per cent. patent, 34 per cent. clear, and 6 per cent. low grade. Its capacity is 500 barrels per 24 hours, and when running on dry and tender wheat it will make 600 barrels easily. A mill operated from this flow can withstand all competition as to the quality of its flour and yield, besides combining with the necessary qualifications, simplicity and economy of operation.

As the first sizing rolls merely crack the middlings, they go to a grading scalper and are treated much better, as this saves abrasion of stock.

All the rolls are 9 by 30 with the exception of two pairs that finish, which are 9 by 24.

There are three aspirators shown working on the coarse middlings.

All the reels shown are round reels, 32 inches by 8 feet except three, Nos. 18, 19 and 21, which are only used as finishing centrifugals.

Purifiers 1 and 2 are No. 2 machines; the rest are No. 1 machines.

The first break has 60 inches of surface, with 10 cuts to the inch, and a differential of 2 to 1. It makes about 25 per cent. of the middlings.

The second break has 90 linear inches of surface, with 12 cuts to the inch, a differential of 2 to 1, and makes about 30 per cent. of clear, sharp middlings.

The third break has 60 linear inches of grinding surface, 14 cuts per inch, a differential of 2½ to 1, and makes about 25 per cent. of clear middlings.

The fourth break has 60 linear inches of break surface, 18 cuts to the inch, a differential of 2½ to 1, and removes the rest of the middlings.

The bran rolls have 60 linear inches of surface, 26 cuts per inch, and a differential of 3 to 1. They will clean the bran without shredding it and leave it clean and flaky.

The scalpers are No. 9 three-sieve standard type.

The break surface in this flow is about 0.66 linear inches per barrel per 24 hours; or about 16 linear inches per barrel per hour.

The smooth or reduction surface is about 0.75 linear inches per barrel per 24 hours, or 20 linear inches per barrel per hour.

If the wheat is tough and hard to reduce, it would be better to use about 18 inches of break surface and 24 inches of smooth or reduction surface per barrel per hour.

The miller should be careful to utilize all the break surface. When it is remembered that one-seventh of an inch will break for a barrel of flour in 24 hours, one can readily see what is lost by not utilizing all the roller surface.

The scalper surface is about 14 square inches per barrel per 24 hours, or 338 square inches per barrel per hour.

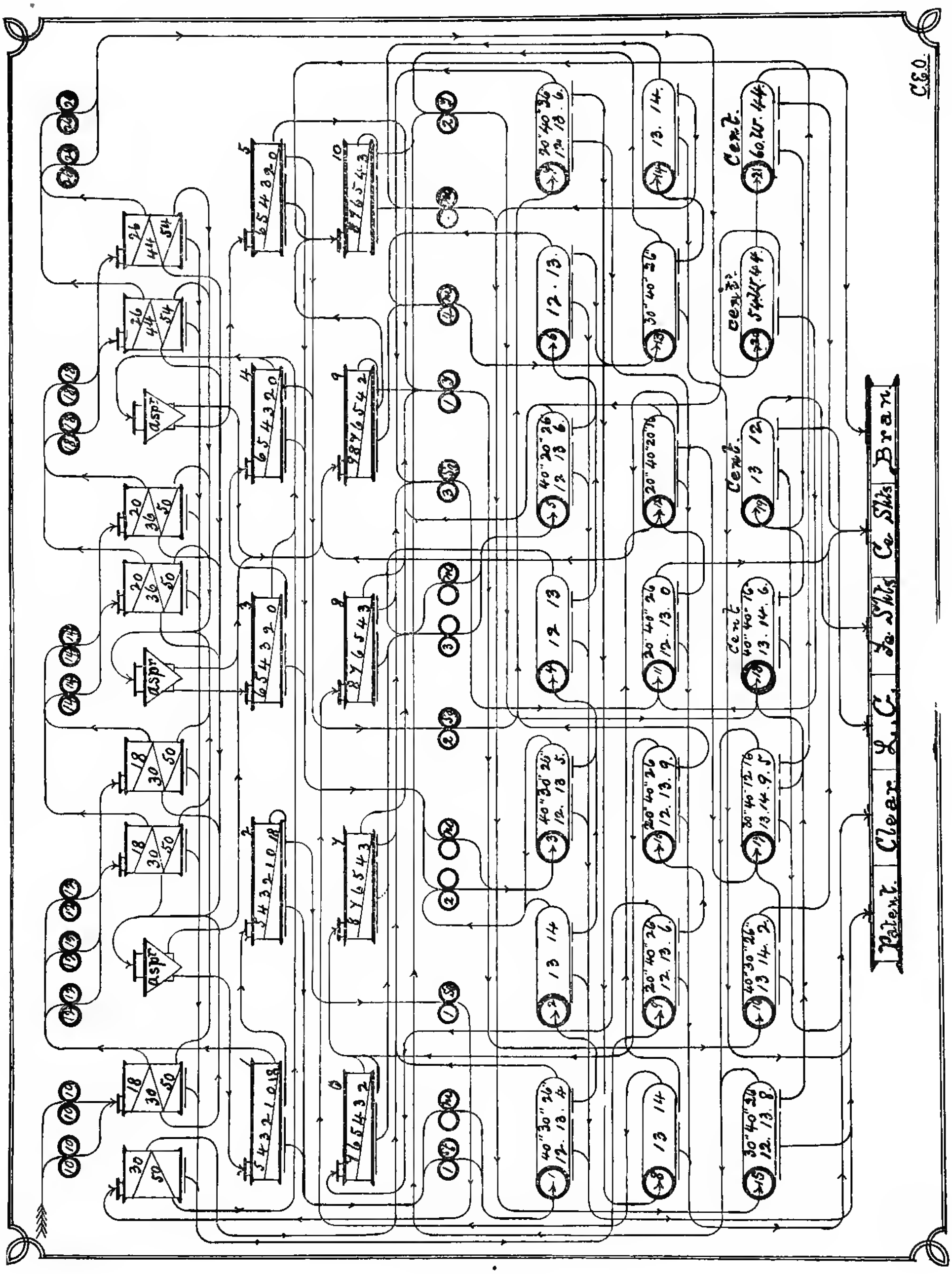


Fig. 19.

The purifying surface is approximately 64 square inches per barrel in 24 hours, or about 1500 square inches per barrel per hour.

The dressing or bolting surface is approximately 350 square inches per barrel in 24 hours, or 8350 square inches per barrel per hour.

The bran cleaning surface is approximately 34 square inches per barrel in 24 hours.

The flows given in the preceding pages are reel mills, with the vibrating or sieve scalpers used very much anti-dating the introduction of the sifters, and which did splendid work up to that time.

These flow sheets vary slightly in the arrangement of machinery, but are about equal in their results when carefully handled by competent men, but would do the same work as any other mill in the hands of incompetents.

If the operator attends strictly to his business all the impurities will be eliminated at the very beginning by the amount of purifiers employed, and the cutting from one purifier to another is good in many instances where the wheat is not at its best.

The flow sheets or "Modus Operandi" following are on the sifter system, and each one will be self explanatory to all knowing any thing about the operation of a mill, and they will be a puzzle to those who do not.

In Fig. 20 I give a flow sheet of 2 breaks and 4 reductions, sifter system.

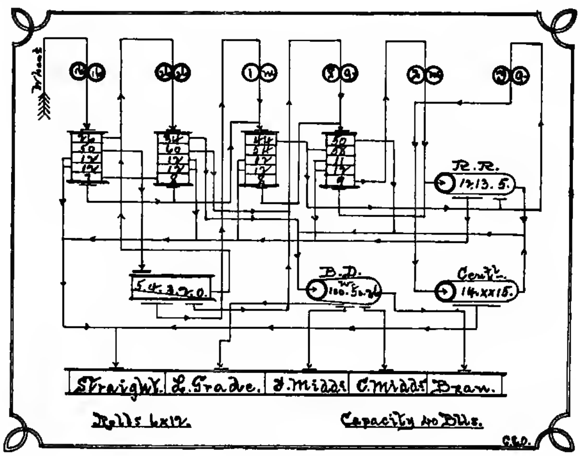


Fig. 20.

The first break has 16 corrugations, differential 2½ to 1; spiral 1 inch to the foot same as all the rolls; break about three-fourths as carefully as possible in order to obtain all the large middlings it is possible, and leaving the chop granular and lively, but not musty and soft.

The 2nd break has 26 cuts, differential 3 to 1; break or grind just close enough to clean the bran but not to chip or shred it, and to be correct there should be a slight imprint of the corrugations in the bran.

There is no length in this flow sheet to allow for sizing, so it is necessary to grind close on the first germ or sizing roll, as the tail over goes direct to bran duster, yet it must not be squeezed to mush, or the germ oil will permeate the stock and will make the flour yellow.

Grind on all the middlings rolls just enough to leave the stock mealy, smooth but not flaked, and it will bolt freely, and will give a better yield than when mashed to flakes.

Differentials, first middlings roll 2½ to 1; sizing or germ roll 2½ to 1; second middlings roll 3 to 1; tailings roll 3 to 1; *sending all bran and the finished shorts* to bran duster.

Top sieves on break sifters are clothed with wire; all numbers from 20 to 70 are G. G. bran duster is wire; all the remainder are silk XX.

Fig. 21 is a 3-break and five reduction flow sheet, 65 to 75 barrels capacity in 24 hours; and comprising 4 double stands of rolls 6 x 15, making 120 linear inches, or 1.84 linear inches per barrel per 24 hours.

The first break has 14 corrugations per inch, "V" shape, the same as all my cuts, unless running on brittle wheat. Spiral 1 inch per foot, same as on all my flow sheets; differential 2 to 1; break about two-fifths, or until stock appears about half large, granular middlings, but not mashed or mushy.

The second break has 18 corrugations, differential 2½ to 1; break about three-fourths, or just so as to shape the bran but not to clean it, or close enough to mash the middlings, which is so often done by millers afraid they will not get the yield, and think they get more yield by close breaking, when in reality they get less flour.

When the stock is granular it will bolt more freely, the middlings are free from dust, they bolt more freely, the rolls have more capacity, and the yield is better.

The third break has 26 cuts; differential 3 to 1; grind until the bran is just clean, or until there is a slight imprint of the cuts, flutes or corrugations left in the bran.

This flow is well balanced, and the products are very good with offals very clean.

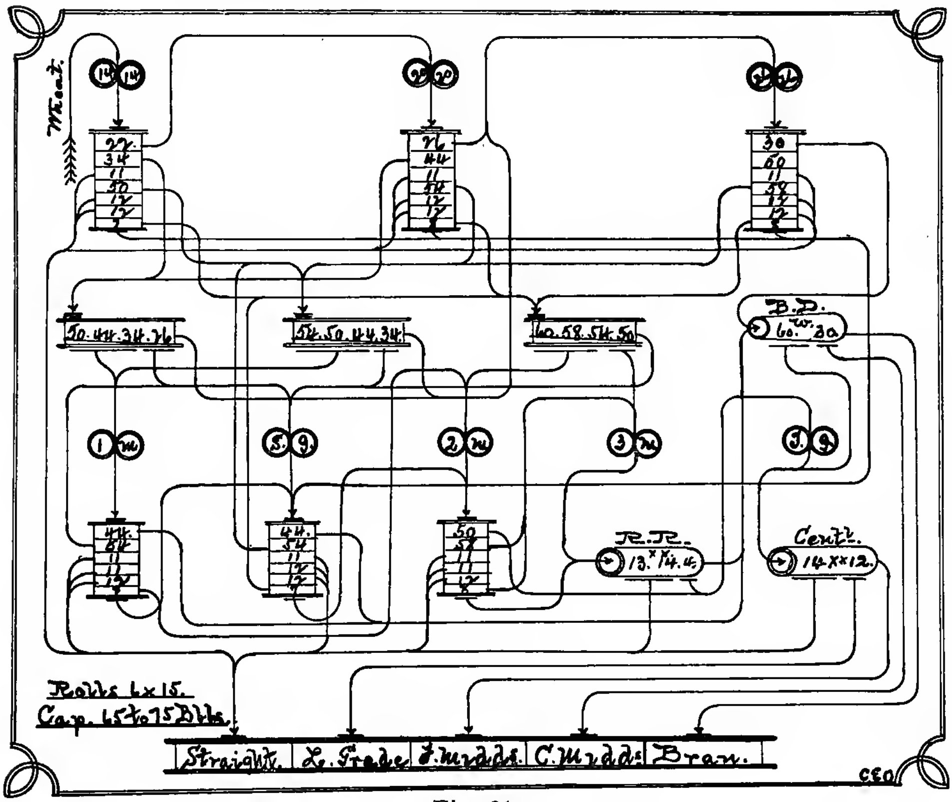


Fig. 21.

The first middlings and sizing roll differential 2 to 1; second and third middlings roll 2½ to 1; tailings or finishing roll 3 to 1.

This flow can be made to give patent and straight flour.

In Fig. 22 you have a four break, six reduction flow sheet, or "Modus Operandi" with rolls 9 x 18 and 9 x 24, making patent or straight grades of flour.

This flow allows for the proper grading and purification of the middlings, and good separations in all stocks, giving good flour, and good yields.

There is a slight difference in the number of corrugations between the different flow sheets, but I have produced splendid results from them all, as one or two cuts makes very little difference when the rolls are in perfect running order.

A miller must be so experienced in handling the different cuts of different makers, the dull and the sharp, etc., that he can so adjust his rolls so that they will give the chop just as desired.

It takes a miller in every sense of the word to adjust newly corrugated rolls to do the breaking as it ought to be done until they become dulled, and if they are not correctly set they will chop the bran to pieces.

The 1st break rolls are 9 x 18; have 12 cuts, flutes or corrugations per inch; differential 2 to 1; break about two-fifths, or to show about half large, sharp middlings when running the chop from one hand to the other when adjusting the rolls.

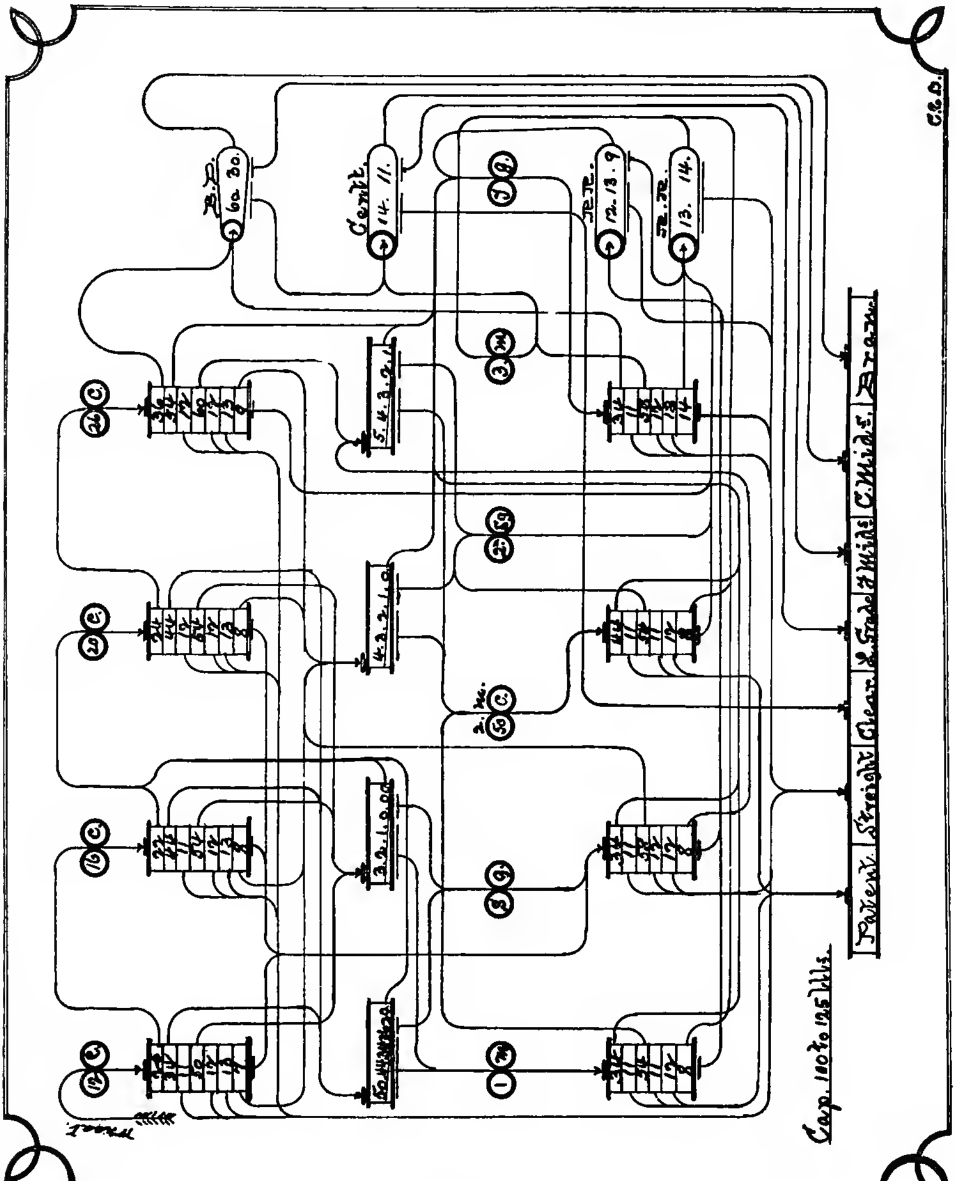


Fig. 22.

The 2nd break rolls are 9 x 24; have 16 corrugations; differential 2 to 1; break about three-fifths or just enough to get the most large, granular middlings, and have the chop sharp, and with as little break flour as it is possible.

The 3rd break rolls are 9 x 24; have 20 cuts per inch; differential 2½ to 1; spiral same as all rolls doing the breaking, namely, 1 inch per foot. Break about four-fifths, or just enough to shape the bran, but not to scrape it, or the middlings will be mashed into powder, and on this roll depends results of purification, and also the quantity of the middlings, as there is more danger of smashing the middlings on this break than any, yet it has to be set right in order to leave the bran in correct shape for the last operation.

So many operatives set this break so close that the stock is only mush, and the bran is so clean that it is useless to send it to the bran roll, and the middlings have been ground into break flour.

The 4th break or bran rolls are 9 x 18; have 26 cuts per inch; differential 3 to 1; break or grind just enough to clean the bran, or loosen the remaining stock therein, and just to show a slight imprint of the cuts in the bran, but not to chip it, which is a very important question in correct milling.

The 1st middlings rolls are 9 x 24; grind until the stock feels mealy, loose and smooth, but not gritty, and do not mash it into flakes, for by tracing it on flow sheet No. 22 you will see that you can get another good chance at the same middlings on roll marked "2 m, 50 C." which may be from 40 to 70 cuts and do good work.

The 1st sizing rolls "s. g." takes the large, germ middlings, crack them about three-fourths, and from which are produced some of the finest and purest middlings in the whole process, which also go to 2nd middlings roll.

These rolls are 9 x 24; differential 2 to 1; and may be corrugated 30 to 40 per inch, and do splendid work in competent hands.

The 2nd middlings "2 m." and 2nd sizing "2 s. g." rolls are 9 x 18; differential 2½ to 1; grind to leave the stock on each mealy, loose and smooth, but not squeeze to pulp, then it will bolt and assist in getting a close yield, granular flour, and with the smallest amount of power used.

The 3rd middlings "3 m." and tailings "Tg." rolls are 9 x 18; differential 3 to 1; grind well down, but do not flake the stock, as that does not assist the yield, but on the contrary presses the flour so tight to the feed that it will not bolt off, and when it does the flour is soft and lifeless.

This flow, in the hands of a competent miller will make very fine products, and as many different grades of flour and feed as required.

In the different flow sheets it will be noticed that the lines running from the flour numbers are taken from the side of the sifter at the flour numbers, but in reality they ought to run from beneath the flour numbers, but this book is written for instructing millers, so that it is not necessary to make the extra lines and make the flows to complicated for the boys.

In Fig. 23 I give a flow sheet with five breaks and nine reductions, and it is the same as the rest of my flows, self explanatory to men understanding milling.

The length of this flow permits almost perfect separations, and in competent hands will give products as fine as anything on the market; and its simplicity will make it economical to a marked degree.

The first break is 9 x 24; has 12 cuts, flutes or corrugations per inch; differential 2 to 1; break about two-fifths, or until the stock appears about one-third large, sharp middlings.

The second break should have 14 cuts; differential 2 to 1; they are 9 x 30; break about two-fifths, or until the stock appears about two-fifths large, sharp middlings.

The 3rd break rolls are 9 x 30; with 16 corrugations; differential 2½ to 1; break about three-fifths, or until the stock when passing it from one hand to the other while setting the rolls appears about two-fifths middlings, sharp and free from break flour.

Be very careful with this break, for the corrugations are coarse, and it must produce all the large middlings possible, and the bran must not be shaped on this

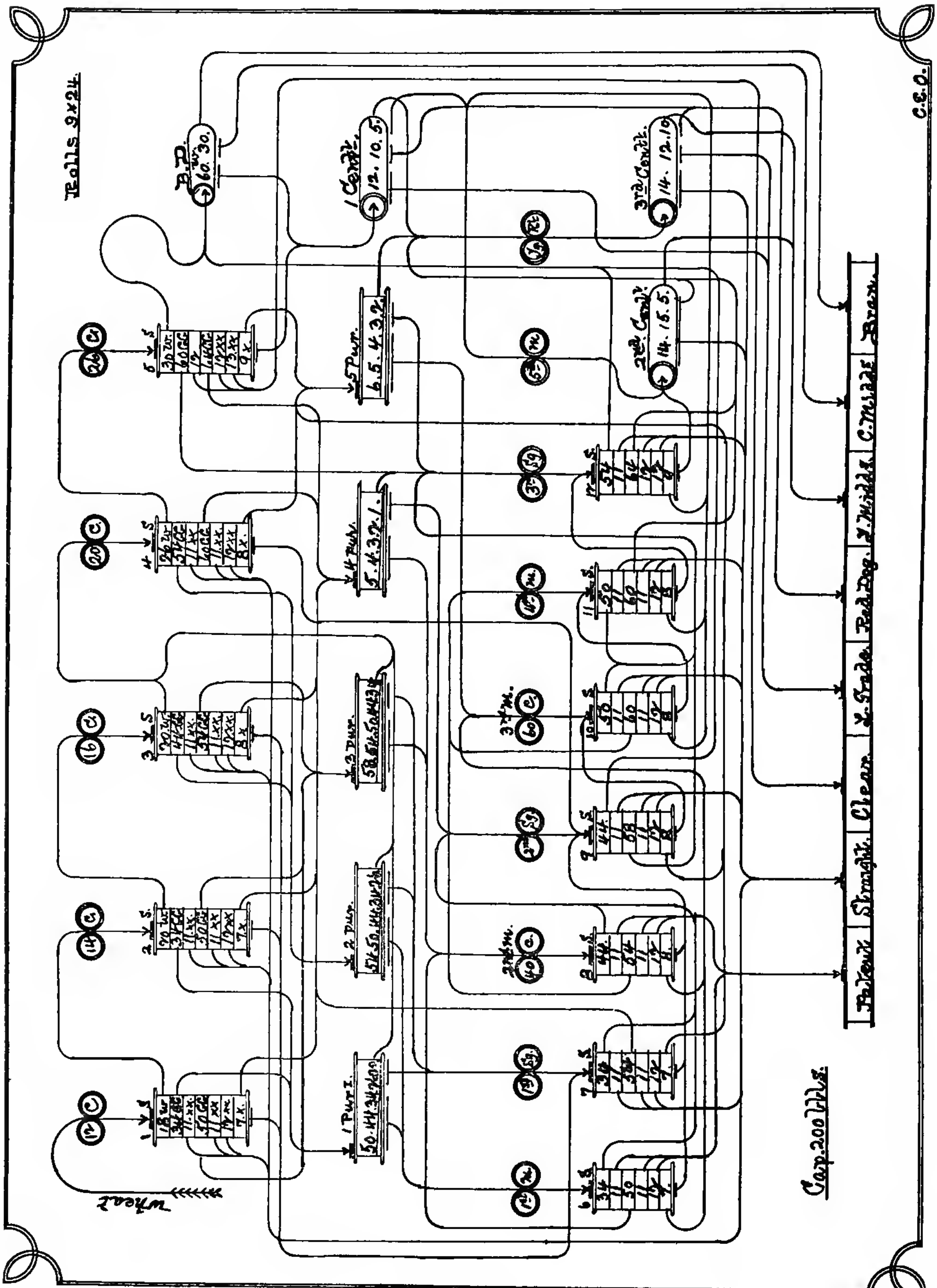

Rolls 9x24
C.E.O.
Wheat
Cap. 200 bbls.
Patent
Straight
Clear
L. Grade
Red Dog
Bran

Fig. 23.

break or the middlings will be mashed to powder and ruined as far as purification is concerned.

The 4th break rolls are 9 x 24; 20 cuts; differential 2½ to 1; break just in order to shape the bran, yet not to clean it, for there are remaining therein fine, granular middlings which are purifiable if removed with care, and not mashed.

The fifth break or bran rolls are 9 x 24; with 26 cuts; differential 3 to 1; break just enough to clean but not to shred the bran. The bran needs only to be touched with the sharp cuts in order for the scalper and bran duster to make it perfectly clean.

The 1st middlings rolls are 9 x 30; differential 2 to 1; grind about three-fourths, or until the stock is mealy, loose and granular.

The 1st sizing rolls are 9 x 30; differential 2 to 1; just crack the stock about three-fifths in order to obtain large, sharp middlings of the second class size, which when purified are the finest in the mill.

The 2nd middlings rolls are 9 x 24; differential 2 to 1; with 40 to 60 cuts per inch; grind until the stock is soft and mealy, yet not mushy and oily, or soft flour is the result.

The 2nd sizing rolls are 9 x 24; differential 2 to 1; crack about three-forths, or enough to get the most sharp middlings for purification.

The 3rd middlings rolls are 9 x 24; with 50 to 70 cuts per inch; differential 2 to 1; soften or grind until the stock is floury, but not soft, or it will not bolt freely and make granular flour.

The 4th middlings and 3rd sizing rolls are 9 x 24; differential 2½ to 1.

The 5th middlings and tailings rolls are 9 x 24, differential 3 to 1; grind on these last four rolls just enough to make the stock warm, mealy and soft to the touch, but not flaked and squeezed until it will not bolt, which is a waste of power, and a flour killer, with a deficient yield.

When purifying, cut all impure stock to sizing rolls, so they may be cracked, bolted, graded and repurified; for it is a grand work, and herein lies the art of good milling, and better products; for gradual reduction is the best of all, and with finest goods possible it is easier to meet competition.

In Fig. 24 (see page 64) is presented to you a flow sheet of 600 barrels capacity in twenty-four hours, and with good wheat it will make 750 barrels, or approximately 525 280-pound sacks.

It is a six break thirteen reduction mill, is very complete in every detail, and with this mill it is possible to get almost perfect separations at every stage of the process, and by having four sizings it allows of perfect purification of the middlings.

There is no mill that will give more or finer large middlings than this arrangement, for it gives the mode of gradual reduction, and by the coarser corrugations at the head of the mill the large middlings when separated from the berry have a means of escape into the crease before being cracked again.

All the roller mills are 9 x 30, and for use in England they may be 10 x 60; and the linear inches per barrel are approximately 1.60 per twenty-four hours.

The first break should have ten corrugations, cuts or flutes; differential 1¾ to 1; break about two-sixths, or until there is about one-fifth large, sharp middlings in the stock when passing it from one hand to the other.

Second break twelve corrugations; differential 2 to 1; break about two-fifths, or until there is about two-fifths large middlings in the chop.

The 3rd break 14 corrugations; differential 2 to 1; break about half, or until there is about three-fifths of the stock or chop large midddlings.

The 4th break 16 cuts per inch; differential 2 to 1; break about three-fifths, or until about half the stock is middlings and as free from flour as it is possible. On this break the bran will just be getting into shape.

The 5th break 20 cuts; differential 2½ to 1; break about three-fourths, or until the bran is just shaped to its natural or true size, but not close enough to scrape it, or the middlings will be ground to powder, and in truth ruined as far as purification

is concerned. This break requires more careful attention in its manipulation than any other in the entire mill, or a larger percentage of break flour is the result.

The 6th break or bran roll has 26 corrugations; differential 3 to 1; grind until the bran is just clean, or until there is a slight imprint of the cuts left in it, and upon no account shred the bran.

All numbers on the top sieve of sifters from Nos. 18 to 30 are wire cloths; all numbers from 34 to 60 are gritz gauze; all the rest are XX bolting cloth. The bran and shorts dusters are clothed with wire.

No. 1 middlings rolls should have a differential of 2 to 1; grind until the stock is mealy and smooth, not gritty, but not by any means flaked, and some of the finest patent ought to be secured from these middlings. From these middlings you secure after bolting, very fine stock, which being joined by No. 2 from purifiers make about the purest in the process if in the hands of a real miller.

The 1st, 2nd and 3rd sizing rolls should just crack the stock so that it may be bolted, graded and repurified ready for further reduction by the smooth rolls.

To remove pure germ in flakes the middlings must come through No. 00 to 0000 cloth, pressed into flakes, bolted and sent to purifier with the tail sheet of 0000 cloth, 16 G. G., or 16 wire, when the sweet, yellow flakes of pure germ will tail over.

2nd middlings roll differential 2 to 1; 50 corrugations per inch; chop or grind to make the stock mealy and smooth, but not gritty, when you ought to get best flour in the process.

3rd middlings roll 60 cuts, flutes or corrugations per inch; differential same as the preceding, grind the stock smooth and mealy, or until it just feels warm to the touch, when it will bolt clear and granular, and make a splendid granular flour with a slight orange tint.

4th middlings roll smooth or 70 cuts per inch; differential 2 to 1; grind to make the stock mealy and smooth or slightly warm to the touch, when it too will make beautiful orange tinted patent flour.

5th middlings and 4th sizing roll differential 2½ to 1.

6th middlings and 1st tailings rolls 2½ to 1 differential.

7th middlings and 2nd tailings roll differential 3 to 1.

Grind on the tailings and 5, 6 and 7 middlings to have the stock smooth, but not flaked, and by having the 2½ and 3 to 1 differential it requires less pressure, but has more grinding, it bolts better, and takes less power to operate, and a better yield is obtained.

The capacity of the purifiers and bolters for this flow would have to be secured from the mill builders to compare with the capacity of the rolls.

In handling a mill, it is necessary for the miller to keep the flow in his mind, to know the kind of stock in the different spouts, its origin, destination, and flour-making qualities. The mills are so arranged, that changing a single slide on a purifier will alter greatly the feed on a roll, so that, unless the miller in charge is familiar with the stock, he is not capable of changing the slides or of operating the mill at all.

The flows that have been given above are designed to prodce each grade of flour of equal sized granules as near as possible; for unless the flour is so produced, the fermentation of the different sized particles is so varied, that the flour does not produce so good a loaf of bread. This is a very important factor in the manufacture of flour. Another important factor where the intelligence and alertness of the miller counts, is the uniformity of the mill's products. To keep the mill's work up to a constant standard requires the miller to utilize continually the four senses of sight, smell, hearing and feeling. The eye informs him of the size, position, shape and color of bodies; and in a mill the quick eye of the miller detects at a distance a belt off or in trouble, the smoke of a hot bearing, the dust from an elevator choke, etc. The sense of smell tells him when a bearing is hot, and other odors inform him of a slipping belt, damp, must, smut, weevil, etc.

Touch or the sense of feeling informs him of the form, hardness, texture and

temperature of bodies; and in a mill the grinder must keep his hands as soft as possible. Grinding with burrs was guided by touch altogether, while with rolls it is governed by both sight and feeling. The sense of hearing is a handy monitor of any unusual noise in the machinery, showing that something is not right.

The flows given above are to be worked on the gradual reduction system of milling, which is the only true method of obtaining flour of even granulation.

When a mill's reputation for a certain grade of flour is once established, the same kind of wheat should always be ground.

When a new mill is built, the party in charge of the construction should see that it will be operated by a competent man who understands his business, or it will not produce results equal to the work on its trial for acceptance. Some mills are built with the understanding between the millowner and mill fiurnisher that the mill is to be so simple that anyone can operate it. This is folly. No mill will produce good results automatically, no matter how perfect the mill and its flow may be.

Sometimes mills are built under a guarantee to give certain results which are almost impossible. When the day arrives for its trial for acceptance, one or two expert millers are on hand who are able to work and crowd it to its utmost capacity, and obtain results that can not be secured by the everyday miller after the experts have gone, of course a good miller can be obtained; but too often the proprietor puts in a cheap man who does not take very long to put the mill on the market for sale.

There are men who are really experts engaged by mill builders; but there are others who are only half grown as practical and theoretical millers. This can not be denied when the following machinery is diagrammed into a mill of fifty barrels capacity: Four stands of 7 x 18 rolls, 1 purifier, 6 round reels, 2 hexagons, two centrifugals, 3 sieve scalpers and a bran duster. This is an actual case. Here he had a roll capacity for 75 barrels, scalpers for 50 barrels, purifier for 25 barrels, bran duster for 100 barrels and dressing capacity for 170 barrels or more.

In this connection it may be well for the writer to state his idea of the different surfaces requisite to produce a barrel of flour with little power, and to do the work without overcrowding any part.

The break surface is 18 linear inches per barrel per hour for winter wheat, 15 linear inches per barrel for spring wheat.

The smooth roll surface is 24 linear inches per barrel per hour for winter wheat, and 26 linear inches per barrel per hour for spring wheat.

The scalper surface is 338 square inches of sieve surface per barrel per hour for winter wheat, and from 10 to 15 per cent. less for spring wheat. There is generally three times this amount allowed when hexagon or round reels are used.

The purifying surface is 1,500 square inches per barrel per hour on winter wheat, and five per cent. less for spring wheat. Every inch of cloth must be utilized on purifiers in order to do good work.

The grading surface allowed on the combined sieve scalper and grader is generally much more than is really necessary. The writer has known it to take 700 square inches on first and second middlings, and a reel of 800 square inches of surface on third middlings per barrel per hour. The surface necessary is 800 square inches per barrel per hour on winter wheat and 700 square inches on spring wheat.

The dressing surface for round reels is 8,000 square inches per barrel per hour. For hexagons, add 25%. These figures are for winter wheat. For spring wheat reduce them 10%.

The bran cleaning surface is about 300 square inches per barrel per hour, but nearly double that amount is usually provided. It is not necessary if the bran rolls are working properly.

The foregoing is the working surfaces that give the best satisfaction in my estimation. Doubtless some will differ in opinion, but the writer can only say that during his milling career he carefully watched the performance of each machine, and took pains to ascertain the facts of capacity.

The surfaces given will be just sufficient to do the work as it ought to be done, and the feed on each machine can be evenly divided.

A mill ought to be planned and built so that after it is ready to run no changes in its flow will be necessary until improvements in the art of milling are made that will enhance the quality of the mill's products. Nevertheless, it is a common thing to see mills overhauled almost before they are completed. This certainly betokens a lack of knowledge somewhere that is disastrous to the mill owner. The writer knows a large firm owning several fine mill buildings. The plants that were put in had to be rearranged at the commencement, and the firm was put to so much expense that it was forced to make an assignment.

The manager or owner of a flour mill who himself knows nothing of the practical running of a mill, should never undertake to order a new mill or machinery without first consulting his miller. If he buys without such advice, he is apt to pay for lots of unnecessary machinery, and get a poor mill in the bargain. If the miller cannot be trusted in such a matter, he ought not to be retained in charge of the mill.

To the majority of small millers making a flow sheet it appears arduous work, if not impossible, but it only requires a rule, pencil and compass to make a fair flow sheet, and one can be made with rule and pencil only. Of course a better one can be made by having a drawing board and a full set of instruments. Making a flow sheet from memory is quite easy when you have the knowledge. But to make a correct one and build a mill from it that will withstand competition requires years of diligent observation and comparison of different machines and processes.

As noted in a previous chapter, every miller in charge ought to understand and be able to make a correct flow of the mill he is operating. He cannot mill intelligently or make changes understandingly unless he does thoroughly understand the flow and is able to reduce it if necessary to paper.

It will be noticed that the flow sheets illustrated in this work are as nearly square as possible, and this the writer is convinced is the model recommended to students desirous of becoming proficient in the drawing of the same.

The surface given in the flow sheets on preceding pages is for reel mills, and this surface may be reduced fully 60% for sifters, and the reason for this is that while only about one-third of the surface of reels is used in operation, almost the entire surface of sifters is in use while in motion.

There appears to be a great divergence of opinion in relation to the amount of scalping, purifying and bolting surface required per barrel of flour produced, and the mill builders appear at variance in this regard, and it would be very beneficial if there was a standard fixed for each of these important functions of milling.

There are scarcely any two headmillers or grinders either that grind exactly equal, therefore it would require different amounts of bolting surface for each miller, for we must grind to bolt according to the bolting surface at our command, or the rest of the machines cannot work harmoniously.

A flow sheet to a miller is just as essential as a rudder to a vessel, and especially to a miller just taking charge of a mill, for it will be of great assistance in becoming familiar with the flow of the stock, and by looking it over several times it can be committed to memory almost accurately, and save many steps and extra work.

The author stands ready to supply flow sheets at small cost for any kind or size of mill according to capacity, and also corrects flow sheets of all kinds and sizes of mills at moderate cost, and the work is done with great care and consideration.

The wheat that ought to be used on the foregoing flow sheets ought to be soft winter or highly tempered hard wheat.

I always prefer a "V" cut unless it is on very hard and brittle wheat, when I use sharp to dull.

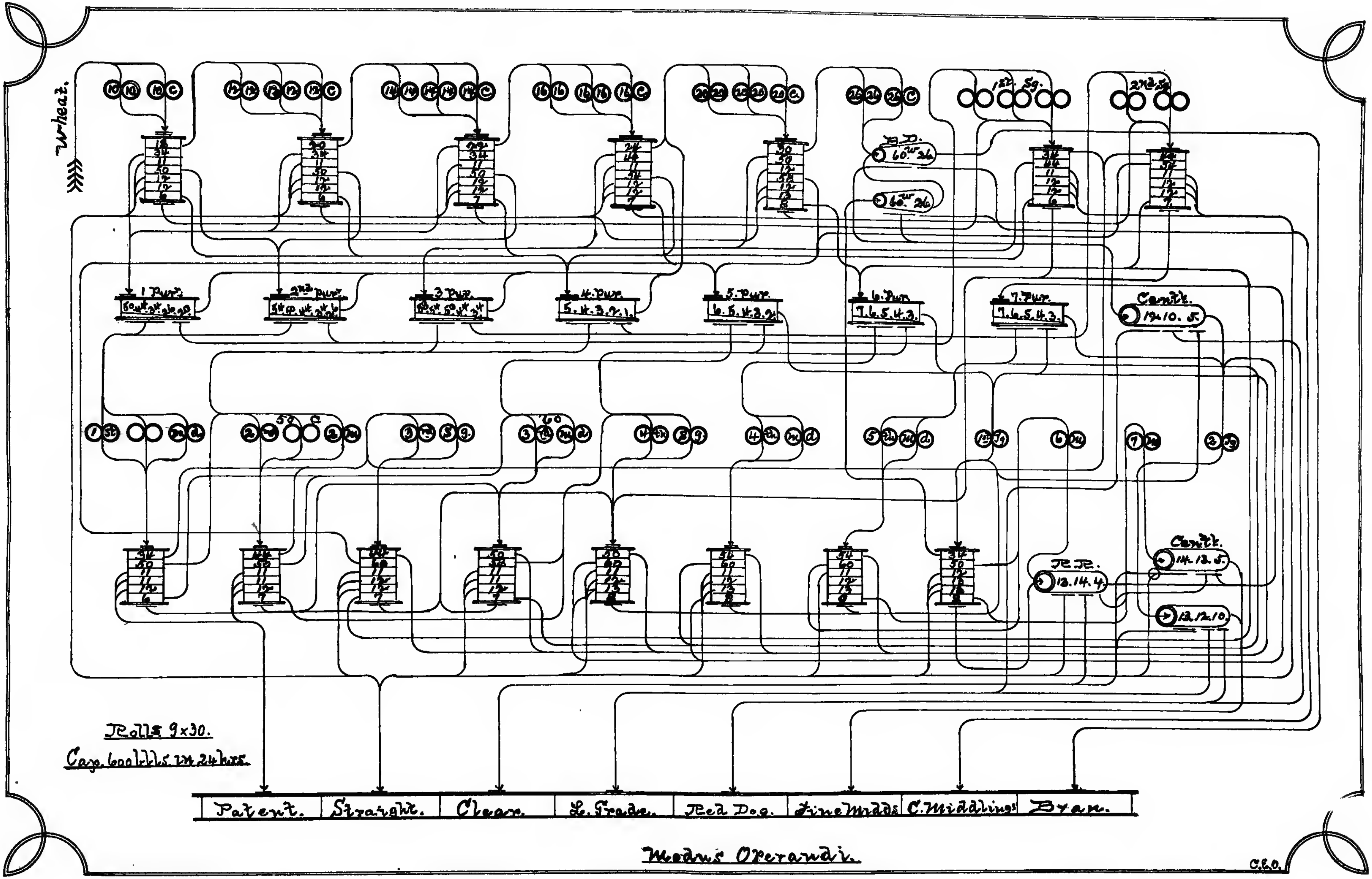

Wheat.
1st. Sg.
2nd Sg.
1 Pur.
2nd Pur.
3 Pur.
4 Pur.
5 Pur.
6 Pur.
7 Pur.
Centr.
R.R.
Rolls 9x30.
Cap. 600 bbls. in 24 hrs.
Patent.
Straight.
Clear.
L. Grade.
Red Dog.
Fine Midds.
C. Middlings
Bran.
Modus Operandi.
C.E.O.

Fig. 24.

CHAPTER XVII.

MILL PRODUCTS.

The names used to designate the various mill products are many, and various methods are employed packing and removing them from the spouts.

Flour in the English speaking countries is generally named the following: Top patent—high patent—Minneapolis top patent—Kansas top patent—Canadian top patent—Minnesota patent—Kansas patent—Canadian patent—Australian patent—Hungarian patent—First patent—First patent—Manitoban patent—Winter patent—Soft winter patent—Hard winter patent—Spring patent—Choice patent—French patent—Minn. 1st patent—Minn. ordinary export patent—Canadian export patent—Country patents—Roller patent—Extra superfines—Short patent—Long patent—Second patents—Ordinary patents—American spring patents—Canadian spring patent—Local patent—double supers—Superfines—Leather tie patent — Extras — Supers—Hungarian 0,00,000,0000 patents.

These I believe will suffice to show how many patents there are in the English speaking world, and many more I have not mentioned, and now I give what are approximately straight grades: Straight—Straight winter—Straight spring—Straight Kansas—Town households—Households—Fines—No. 1 town households—Roller whites—Country straight run—Bakers households—Cut straight—Half patent—Best seconds—Whites—Plain tie—Seconds—Canadian winter straights—Second patents, etc.

Other flours of lower grades: First clear—Second clear—Bakers—Low grade—No grade—Fancy—Extra fancy—Extra—Choice clear—Red dog—Top clears—Seconds—Best seconds—Thirds.

Various names for fine middlings: Fine middlings—Sharps—Fine sharps—Shorts—Fine shorts—Fine pollard—Ships—Fine ships—Pig feed—Hog feed—Thirds—Fine thirds—Common thirds, etc.

Coarse middlings—Germ middlings—Pollard—Coarse pollard—Shorts—Coarse shorts—Ships—Coarse ships—Pig feed—Coarse middlings—Fine bran—Rough pollard—Sharps—Coarse sharps—Ship stuff—Germ shorts, etc.

Bran—Broad bran—Coarse bran—Medium bran—Small bran—Fine bran, etc. In England they make a specialty of very broad bran for which they get an extra price. They even go so far as to separate the broad bran and pass it through a pair of squeezing rolls to broaden it out, making it very broad indeed.

There is a great deal of what is called Mixed feed solid, which is bran and middlings mixed together.

There are intervals when feed is selling as high as the cost of the wheat and lower grades of flour, and then it is no use getting the yield so close.

Chapter XVIII.

YIELDS OR PERCENTAGES.

The percentage, yield, test or trial or whatever name it may be the most familiar to the brothers is the all important question in the operation of a successful and profitable milling business.

Unless it is known to the most minute detail just how much wheat it is taking to produce a barrel of flour, it is not possible to send out quotations for any of the mill products with accuracy.

There are all kinds and conditions of wheat; thick bran, medium bran and thin bran; brittle wheat, tough wheat, dry wheat, tender wheat, and moist wheat and all depends upon the kind of wheat for getting certain yields or percentages.

There are wheats that will yield as low as 4.16 bushels or 256 lbs. of wheat per barrel; and there are others that will require over 5 bushels per barrel, and it is up to every mill owner to be sure how much his particular mill is taking per barrel of flour produced.

Now, brother millers, just allow me to emphasize this point very forcibly "Do not use any guess work with the yields, but be absolutely certain of this fact" for unless the owner is certain he can not be sure of a profit.

I want to say here that to operate a mill without knowing positively the percentages or yield is to run it into bankruptcy.

There is not a miller that can abstract more flour from a grain of wheat than that grain of wheat contains, and as the analysis gives it approximately as 84%, I do not think it possible for any mill to give over 78% of flour unless decortication be resorted to.

Low grade flour should not be figured into the percentages unless it is milled through No. 13 to No. 16 cloth, and if it be milled through No. 9 as some do it cannot be called flour for the reason that it is fully 70% feed.

There is no gainsaying the fact that any good and conscientious miller will always mill according to the average mixture of wheat coming to the mill, and he ought not for one moment sacrifice quality for percentage, or vice versa.

There is no sane miller would expect to get the same percentage of flour from 58 lb. test as from wheat testing 64 lbs. per bushel unless the 64 lb. wheat had very thick, tough bran, and that of 58 lb. test had very thin and brittle bran which very often happens, so it is up to each millowner to know his own percentages according to the wheat he is milling. The most important of all the taking of yields is to be absolutely correct and honest, and a miller who will deceive his employer when taking the percentages is nothing short of a criminal, for he is wilfully robbing his employer; injurig his own position, and making an unprofitable mill.

When I was in charge of mills I was always more concerned than my employer regarding my yields, for I would no more think of operating a mill without knowing my percentages than I would think of taking a ship to sea without a rudder.

I have known millers to go round the mill just before finishing the test, knocking the reels to get more flour, also allowing the flour to run a few minutes after the feed had been stopped in order to get more percentage of flour, and it is an outrage on the face of it.

I have often gone into mills, and after examining the offals have asked the proprietor or miller how much they were taking to make a barrel of flour, and all with scarcely an exception would say 4.30 bushels per barrel, when I knew almost to a certainty that it was taking over five bushels.

It is not necessary to weigh the wheat when taking the yields or percentages, but merely weigh all the products taken off the mill at a given signal, for what comes ott the mill in products must have gone onto the mill as wheat.

The following is an approximate yield or test from 1000 lbs. of wheat when weighed onto the mill:

Flour.	Lbs.	Percentage.	Per Bbl.
Patent	400	40%	78.40
Clear	200	20%	39.20
Low grade	100	10%	19.60
Red dog	50	5%	9.60
Shorts or middlings	110	11%	21.56
Bran	110	11%	21.56
Screenings, etc.	10	1%	1.96
Invisible loss	20	2%	3.92
	1000 lbs. wheat.	100%	196 lbs. per bbl.

There is divergence of opinion amongst the milling profession regarding the invisible loss, but there is no doubt but what it takes place by evaporation, for when wheat is tempered excessively it will increase instead of being invisible loss.

The following is an approximate yield when packing from the stream by weighing all products taken off very accurately during a given time:

Patent flour	400 lbs. or	40%
Cut straight	340 lbs. or	34%
Low grade	30 lbs. or	3%
Fine middlings	20 lbs. or	2%
Coarse middlings	70 lbs. or	7%
Bran	100 lbs. or	10%
Screenings	20 lbs. or	2%
Invisible loss	20 lbs. or	2%
	Wheat 1000 lbs.	100%

To obtain the percentage of flour obtained proceed in the following way:

Multiply the 400 lbs. of patent by the 100 per cent. and divide the quotient by the 1000 lbs. of wheat.

The arithmetical form of the above is:

$$400\times100\div1000=40\%.$$

Proceed likewise to obtain the percentage of each product, by having the 1000 lbs. of wheat as a figuring basis it is very easily obtained by cutting of the decimals.

By adding the 400 lbs. of patent, the 340 lbs. straight, and the 30 lbs. of low grade we have a total of 770 lbs. of all the flour, or 77% or 254 2-5 lbs. or four bushels and 14 2-5 lbs. per barrel of flour produced.

To figure the amount of wheat taken per barrel of flour from a given percentage proceed in the following manner:

Multiply the 196 lbs. which a barrel contains, by 100 the per cent., and divide by 77 per cent., the flour obtained, and you have the result, or 254 2-5 lbs., or 4 bushels and 14 2-5 lbs. per barrel.

Arithmetically we have:

196×100÷77=254 2-5 lbs. or 4 bushels and 14 2-5 lbs. per barrel.

To figure the amount of wheat taken per 280 lb. sack "English" of flour from a given percentage we have it in the following arithmetical form:

280×100÷77=6 bushels and 3 3-5 lbs. or 363 3-5 lbs. per sack of 280 lbs.

To find the percentage when bushels are given:

Multiply 196 by 100 and divide by 4 bushels and 14 2-5 lbs. or 254 2-5 lbs.

Arithmetically it is:

196×100÷254 2-5 lbs. or 4 bushels 13 2-5 lbs.=77 per cent.

The above are not actual yields, and are only taken as examples.

When everything a mill is producing is packed from the stream it is an easy matter to take the yield daily according to the tally of the packers, who have to turn in a daily report of everything taken off the mill.

Whenever I was in charge of a mill where it was not possible to pack from the stream, I always had the product spouts so arranged that they could be shut off at a signal instantly, when a two or three hours run could be taken, weighing all the product taken during that run, and calculated as wheat, from which the yield may be figured very accurately when taken with care.

Any miller turning figures into the office that he knows are incorrect surely has a guilty conscience that will trouble him in his latter days, and he will always be ashamed of himself when he is brought into remembrance of the same.

Know your tests; know your cost; be sure of your quality, and do not be afraid to ask a price for good products.

Chapter XIX.

FIGURING COST OF PRODUCTION.

This is one of the most essential and important questions in the milling business, and like the figuring of percentages, it must be absolutely correct or it is impossible to send out quotations with accuracy.

I wish to emphasize this matter and to impress my readers with the fact of not neglecting this very, very important lesson, which is the all important requisite in profitable milling.

Just today I had a letter from a country miller asking me what his cost of production would be, but he said the following: "Do not figure power or help, as my son and me will run the mill, and we have water power."

Just think dear brothers how it is possible for such mills to make a profit, and what about the maintenance and renewal of the water power; and again, is a father and son not worthy of their hire? Most assuredly they are, and this is the reason why so many do not know their cost of production.

This book is not written to teach those who know, but it is to assist those who do not know.

Please bear in mind that there are generally to sides to a question but there is generally three sides to that of milling. The first and most desirable is that of profit, which must be in reality if the mill must be kept in operation; the second is that of making expenses to tide her over dull periods; and the third is that of loss, and which is the most undesirable to any business.

When once a mill becomes involved in any way financially it takes a man of sagacious business ability to bring it back to a prosperous condition; but to often the manager in charge will lose his courage and place it in the hands of a receiver.

I give below an example of figuring the cost of production of a barrel of flour in a 200 bbl. mill for a run of 24 hours, taking into account every item of expense that I can think of entering into that production and the sale of the same.

Debit all coming into the mill, expenses, etc.	Debit.	Credit.
900 bushels wheat at 1.14 per bushel on rolls	$1,026.00	
1600—24½ lb. cotton sacks at 3c each	48.00	
Placing 200 bbls. on cars	10.00	
Commission on 200 bbls. at 10c per bushel	20.00	
Freight on 200 bbls. at 20c per bbl.	40.00	
Proprietor's salary, daily	3.50	
Headmiller or foreman's salary	3.50	
The second or night miller	3.00	
Two engineers	5.00	
Coal passer or assistant	2.00	
Elevator foreman and two roustabouts	6.00	
Two packers	4.50	
Shipping and receiving clerk	2.50	

	Debit.	Credit.
Bookkeeper	3.50	
Stenographer	2.50	
Office expenses, stationery, messages, insurance, etc., at 5c per bbl.	10.00	
Interest on $30,000.00 investment at 6%	6.00	
Depreciation, repairs, etc.	4.00	
Power at 5c per bbl. on 200 bbls.	10.00	
	$1,229.50	
Credit the mill with all goods sold.		
140 bbls. of patent flour at $5.55 in 24½ lb. sacks		$777.00
60 bbls. of clear in 98 lb. cotton sacks at $4.45 per bbls. less 2 bbls for invisible loss		258.10
As it took 270 lbs. or 4 bushels and 30 lbs. of wheat per bbl. of flour, it leaves after deducting 196 lbs. of flour, 74 lbs. of feed; therefore 8,000 lbs. or 4 tons of bran at $26.00 per ton or $1.30 per 100 lbs.		112.00
Also 6,800 lbs. or 3 tons 800 lbs. of shorts or sharps at $29.00 per ton, or $1.45 per 100 lbs.		98.60
		$1,245.70

This example is based on 200 barrels daily capacity running 300 days, and expenses must be based on actual barrels produced.

Separate the debit from the credit and you have $16.20 as the daily profit.

This example is only an approximate one, and it shows a daily profit of $16.20, or for the 300 days $4,860.00, and with the salary of the owner added, $1,080.00, gives an approximate profit of $5,940.00 per annum.

The profit per barrel would be 9.9 cents, or 9-9/10th per bbl., which appears small, yet with some mills of very large capacity it is high, as there are mills that work as low as 5 cents per barrel net profit.

Figure every item of expense regardless of how small, and keep an expense account of every expense incurred, so that there can be no mistake in figuring the total expenses.

Besides keeping a daily tally of all products sent out, there ought to be a yearly account of expenses and the barrels produced, and in that way it would be much more accurate than a daily or weekly tally.

Power must be considered even if it is water power, for there is the investment of canal, penstock, wheel and repairs at 6% interest; also its depreciation and renewal at say 20 years.

Owners salaries must always be figured, as every workman is worthy of his hire, and some one must do the work, and it must be figured into the cost of production.

The cost of handling the wheat until it reaches the first break rolls must be figured, and you will find it is costly too.

The selling cost must be taken from the average expense of selling, and which ought not to be more than 10 cents, but very often is 30 cents, and which will soon put a mill into bankruptcy if not closely watched.

When once the owner or manager becomes familiar with the figuring of the cost of production, etc., it becomes a very easy task, and he is steering the ship to safety when he is absolutely sure of the cost when sending out quotations.

There are not many mills of the present day paying the salaries mentioned in the foregoing example, yet the author knows of 100 barrel mills paying them and are very prosperous.

Buy the best grain as low as possible; make the products of the mill of the highest standard; sell them at a profit according to their true value; do not be afraid to ask a good price for them; sell them to those whom you are sure will pay for them, or more preferable to those paying draft on arrival.

It pays to pay employees all it is possible to, and in return insist upon the best service possible for them to render, which is their bounden duty.

Chapter XX.

MANAGEMENT OF BELTING.

Belting is one of the most important items in the running of all kinds of machinery, and there is nothing that requires more careful attention, for to neglect it means great unnecessary expense.

Many different kinds of belting is used, but those in every day use are the leather, cotton and rubber.

Leather belting is preferable to all other kinds when working in dry places, but in damp places is very unsatisfactory.

Leather belting when working under favorable conditions has more frictional contact with the face of the pulley, and is more uniform in its contact under the various strains under which it is subjected.

Leather belting is generally made in three forms, namely, single, double and light double, and to be at its best must be made out of that part of the hide from the back of the cattle.

Often a double belt has to be resorted to on account of pulleys being too narrow, or for economizing space, but it is not good policy to do that if a single one can be used of the desired width.

Keep leather belting perfectly dry, free from dust by holding a brush on the inner and outer side while in motion; and have them just tight enough to do their work without slipping or heating the bearings.

A belt must be kept soft and pliable in order to be at its best in adhesive power, and the best material for this purpose is good neatsfoot, or castor oil.

To keep belts in good order do the following: Brush both sides of the belt while in motion, and apply half a dozen drops of neatsfoot or good castor oil on the driving side only, and once daily.

So many operative millers apply rosin immediately a belt begins to slip, and which is only a momentary remedy, for it hardens the driving side, and only parts of the belt really touch the surface.

A belt must be soft as the palm of the hand to have the best adhesion, for in that way the entire surface of the belt comes in contact with the face of the pulley and gives the largest percentage of frictional contact.

The very best remedy for slipping or troublesome belts is to widen the pulley and the belt.

Leather belts are good for all distances not under three feet, and when the load is a light one, for very heavy belts the distance should not be too great, twenty feet being sufficient without supports.

Single ply leather belting is very good for the interior elevator belt.

Oak and orange tanned belting is superior to any other.

A belt must receive the tenderest care, and never forget that it requires nursing, and very very careful nursing at the best.

When putting on the oil while in motion drop it on the belt from one side to the other, and not more than a dozen drops daily, or the belting becomes saturated and ruined in many instances.

While the best belting is expensive at first cost, it is nevertheless the most economical in the end, and will pay for itself many times over.

An operative must be on the alert at all times to save the life of belting when it is in trouble, for often it happens that a belt is ruined in a few seconds when slipping if not caught at once.

Belting made from the hides of young cattle are preferable to those made from the old cattle.

The belting made from the hides of young cattle is much stronger than that from old ones.

If leather belting is made from any but the back of the hide it becomes crooked when run under heavy strains, often causing it to run off the pulley, etc.

To get the best service out of belting always run it flesh side to the pulley, for when that side is oiled slightly it has more adhesion, and the belt has longer life.

If a belt is run hair side to it will crack, and when the strength side of the belt becomes hard and cracks the belt has a very short life.

Rubber belting is generally made in the following plys: From 2 to 8 ply, and it is very fine for elevator and driving belts when placed above rather than below the required power.

Dressing should not be used on rubber belting, but the driving surface must be kept clean so that the whole surface meets the whole surface of the pulley face.

Rubber and cotton are much cheaper than leather counting the first cost, but leather is much cheaper in the end.

Cotton belting is good for rough usage and light loads, and it is made in thickness from 2 to 10-ply.

Balata belting is the very best for resisting water, and is from 3-ply up, and made in almost any width.

Red stitched canvas or Gandy belting is the best adapted for heavy work in hot or wet places where it is not possible for leather or rubber to stand.

It is made in thickness from 4 to 10-ply.

To test leather belting, double the belt with the hair side inward; if it puckers it is not of the best quality.

One who knows the characteristics of belting knows at a glance when they will give trouble by extra loading, and is on the lookout for that trouble so as to prevent injury should the belt commence slipping and burning.

Leather belting made from the old oak tanning process are preferable to that of the new process.

I have always run belting the flesh side too the pulley when I was in charge of a mill, but I have worked in mills running them with hair side to, and they did not give such good satisfaction, or yet do they last as long.

If you wish to use dubbin on your belting make it yourself of the following material: 5 lbs. of pure lard to ½-lb. rosin boiled together,and applied to the flesh side of the belt, giving it great adhesive power.

Tanners' dubbin is the very best dressing for the flesh side of a belt, causing it to wear the longest.

Never put a belt on tight enough to spring when in motion, for it will heat the bearing, causing no end of trouble.

Prevent at all times the belt becoming oil soaked, and when in that condition, put powdered chalk all over it while it is on the floor over night, which will bring out the oil to a certain extent.

When a belt becomes very dry and hard, use the following, applying it with a brush or cloth. Take one part tallow and two parts castor oil, boil, and apply it while hot. This is also a sure remedy of preserving the belt against rats and mice.

When a belt becomes very dirty and greasy, take it off, soak it in water from 20 to 30 minutes; take it out and clean it with scrub brush and soap, rinse it and let it dry, then oil on both sides with neatsfoot oil, and when the oil has soaked in it is ready for use.

For preserving the pliability of belting the following is very good:

1 gallon of neatsfoot oil,
1 gallon of tallow,
12 ounces of rosin; dissolve it by heat and mix well.

Apply when cold, after sponging the belt with water, rubbing the mixture well into the leather.

The following is a correct rule for finding the horse power of belting:

Multiply the diameter of the driving pulley in inches by the number of its revolu-

tions per minute; multiply this product by the width of the belt in inches; divide this product by 3,300 for single, and 2,100 for double belting, and the quotient will be the horse power that can be safely transmitted.

The average breaking strain of leather belting 3/16-in. x 1-in. wide is 530 pounds; that of a 3-ply rubber belt is 600 pounds.

A belt at a certain tension is not capable of exerting more than a certain amount of force upon the pulley over which it passes, and it therefore takes a certain time to communicate its own speed to the periphery of that pulley.

Belts are not suitable for establishing a constant relation between several velocities with precision on account of being inclined to slip on the pulleys, though this tendency to slip constitutes one of their great advantages when used on swift and powerful machinery.

It has been ascertained by experiment that the loss due to slipping amounts to about two revolutions in one hundred.

The following table gives the percetnage of slip in open and crossed belts of various lengths.

Parallel Belts length in feet	Per cent of velocity lost by slipping	Crossed Belts length in feet	Per cent of velocity lost by slipping
6	4.2	6	3.5
12	3.9	12	3.2
18	3.6	18	2.9
24	3.3	24	2.6
30	3.0	30	2.3
36	2.7	36	2.0
42	2.5	42	1.8
48	2..3	48	1.6
54	2.1	54	1.4
60	2.9	60	1.2

The foregoing table shows that long belts are less liable to slip than short ones. It will also be seen that a crossed belt possesses a great advantage over an open and parallel belt.

Various materials are used in the manufacture of belting such as vulcanized rubber, paper, sheet iron, etc.

The following is a table of the horse power of single leather, 4-ply rubber, and 4-ply cotton belting, and when not over-loaded.

Speed in feet per min.	WIDTH OF BELT IN INCHES 2 H. P.	3 H. P.	4 H. P.	5 H. P.	6 H P.	8 H. P.	10 H. P.	12 H. P.	14 H. P.	16 H. P.
400	1	1½	2	2½	3	4	5	6	7½	8
600	1½	2¼	5	3¾	4½	6	7½	9	10½	12
600	1½	2¼	3	3¾	4½	6	7½	9	10½	12
800	2	3	4	5	6	8	10	12	14	16
1,000	2½	3¾	5	6¼	7½	10	12½	15	17½	20
1,200	3	4½	6	7½	9	12	15	18	21	24
1,500	3¾	5¾	7½	9½	11½	15	18¾	22½	26½	30
1,800	4½	6¾	9	11¼	13½	18	22½	27	31½	36
2,000	5	7½	10	12½	15	20	25	30	35	40
2,400	6	9	12	15	18	24	30	36	42	48
2,800	7	10½	14	17½	21	28	35	42	49	56
3,000	7½	11¼	15	18¾	22½	30	37½	45	52½	60
5,500	8¾	13	17½	22	26	35	44	52½	61	70
4,000	10	15	20	25	30	40	50	60	70	80
4,500	11¼	17	22½	28	34	45	57	69	78	90
5,000	12½	19	25	31	37½	50	62½	75	87½	100

The motion of a belt should run with and not against the lap.

To determine belt travel in feet per minute:

Multiply the diameter of the driving pulley by 3.14 or 3-1/7 to determine the

circumference, then multiply the circumference in feet. by the revolutions of the driving shaft.

The following is a rule for finding the length of a belt:

First determine the circumference of both pulleys by multiplying the diameter of each pulley by 3.1416 or 3-1/7, now divide the total of both circumferences by 2, if measurements are taken in inches, reduce the result to feet by dividing by 12, add twice the distance between centers of shafts, and allow for splicing.

A horse power is 33,000 pounds raised one foot high in one minute.

Chapter XXI.

FASTENERS FOR BELTING.

Fig. 25 represents the Wilson Belt Hooks. They are metal plates, and very tough. To apply them, lay them teeth upward on a solid block or bench, place the end of the belt on the teeth and with a hammer drive the teeth through the belt and rivet on the flesh or inside. They take the place of a lace joint, and are very serviceable, and much neater than a laced joint.

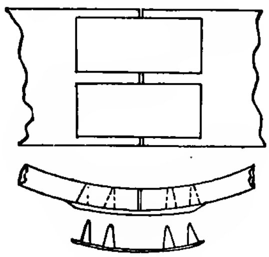


Fig. 25.

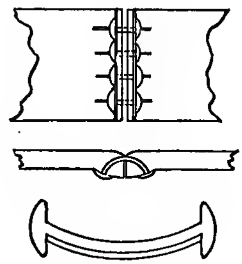


Fig. 26.

The writer has used them very much, and has found them very satisfactory when not too heavily loaded.

Fig. 26 represents the Blake Belt Studs, which are a first-class fastener for belts not using idlers, and not too heavily laden.

They are made in such a manner that they grip almost the entire width of the belt, and they are easily applied.

They do not require any punch holes, but only an incision, therefore the strength of the belt is slightly impaired.

By the use of these studs the edges of the belt are kept very snugly together, and the stud not touching the face of the pulley, the joint is almost noiseless.

There are many different belt fasteners to numerous to illustrate, such as The Bristol Patent Steel Belt Lacing, which can be applied to all kinds and thicknesses of belting.

Smith's Patent Belt Fasteners, which are to be riveted in the outer side of the belt, and may be used for almost any sized belt, and for leather, rubber, cotton, gandy, etc.

Their sizes are Nos. 1-2-3-4, and are especially good for large belts, and elevator belting.

The Buffalo Belt Fastners, are numbered 6-7-8-10-13-15.

They may be used on the smallest up to that of 8-ply belting.

There are also wire belt lace, belt cement, copper rivets and burrs. The Champion Fastener is also very neat and strong.

The alligator flexible steel belt lacing is very good, it requires only a hammer to apply it.

We come now to the most interesting of all belt fasteners, that of leather lacing, and which is a great study for the reason that it is the most common of all fasteners.

In Fig. 27 is given a strong lacing, which is very convenient, is easily applied, and most expeditiously of all when hurried.

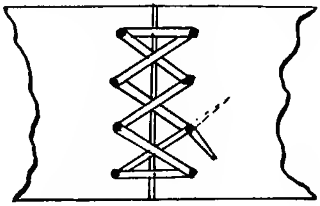


Fig. 27.

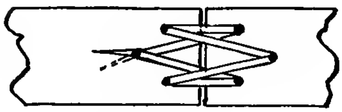


Fig. 28.

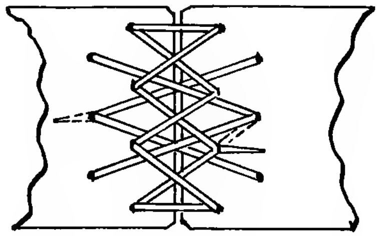


Fig. 29.

It is very durable for light running belts, and when working on the one side only.

This fastener is very durable for belts on bran dusters, purifiers, scalpers, or any light loads.

Fig. 28 represents a lacing that is very good for small belts below two inches in width. It is easily applied, and it is neat and very strong for a small belt.

Fig. 29 gives the ouside view of another good lacing, which is very neat, durable, and easily applied when one is familiar with the same. It will be noted that all these lacings begin and finish in the center, making it very much more difficult for the lace to pull out, and come unfastened.

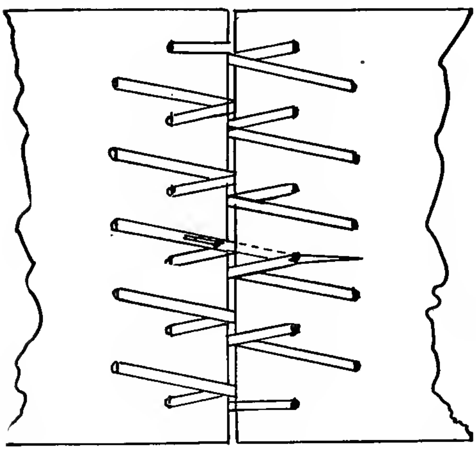


Fig. 30.

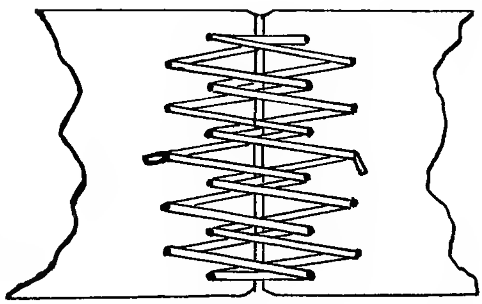


Fig. 31.

I rather prefer the lace in Fig. 29 for the reason that there is more even tension on the lace by all being of the same strength.

In Fig. 30 is represented the hinge joint, which is the most applicable where idlers are used, or where the belt runs over very small and fast running pulleys.

It is very neat and durable when snugly finished, and will last longer than any other lacing when passing over idlers, and over small and fast running pulleys.

This lacing is very good for all belts up to 7 or 8 inches.

Fig. 31 represents the neatest joint of all lacings.

The illustration shows the outside of the joint, and is not so easy to understand as the double cross joint, but is more durable.

The author has applied this lace to driving belts, and has run it for two years without relacing.

This lacing is not recommended where idlers are used.

Never attempt to prepare the ends of belts for fastening without a square; square the ends and cut them by that line, for the holes will pull out when not in line, and it looks much neater when squared.

Do not cut the lace holes any larger than is absolutely necessary, for every hole cut too large, and every unnecessary hole weakens the belt just so much.

If the belt is worth lacing it is worth doing it as neatly and snugly as it is possible to do it.

For belting over four inches in width use a No. 8 punch, oval being the better form to use, cutting the holes longitudinally.

A No. 6 punch should be used for small belting.

A No. 10 punch is right for belts over eight inches.

When lacing a belt it is expedient that each lace is drawn very snug, so that each lap receives the strain equally, and is not so apt to break.

The writer has seen belts laced in such a slovenly manner by those who thought they knew all about belting, that they have come apart several times weekly.

Be careful to keep both ends of the belt as square as it is possible to insure perfect running of the belt on the pulleys.

It is poor policy to cross the lace on the under side for it will soon wear out under certain conditions by the extra friction.

Lace leather is generally very expensive, and it behooves an operative to unlace the joint instead of cutting the lace, when it may be used time and time again.

The strength of a lace depends from what part of the hide it is taken. A lace cut from near the backbone possesses about four times the strength of one taken from any other part of the hide.

The glued or cement joint.—Of all belt fasteners there are none that can compare with the glued or cemented joint.

The first requisite for the gluing of belting is the place on which to prepare the joints, and a bench or table is to be preferred.

A piece of plate glass let into the bench and level with the top, and about a foot from the end is the best of all for the reason that it will not dull the tools so quickly.

The ends of the belt may be planed, scraped and buffed at will over the glass and not be dulled, and a perfect joint can be made.

An eccentric roller made of wood can be arranged on the bench to run both ends of the belt under, and fasten down while being dressed.

To open up joints that are glued the screw-driver is the best tool to use in my estimation to start it, and a pair of good, broad-nosed pliers will rip it open.

To take off the hard glue a piece of windaw glass is good, and the best of all is a round or half moon spokeshave, to be followed by a small smoothing plane, followed by a scraper or buffer.

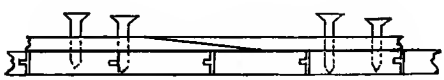


Fig. 32.

The ends must be buffed to hold the glue, and must be prepared as shown in Fig. 32, which also illustrates the method of fastening the same to the floor or board before gluing or cementing.

The best scraper is triangular in shape, made of the best steel, about an eighth

of an inch thick, with the handle in the center, and sharpened at the back to cut similar to that of a plane, with the exception that the plane is pushed, while the scraper is pulled.

This steel scraper can be used for removing the old, hard glue, and for putting an even face to the joint, which is very important indeed.

When nailing the ends to the floor to be glued as shown in Fig. 34, be very careful not to get the upper joint nails within twelve inches from the joint in order to allow the lifting of the flap to apply the glue.

When nailing to the floor it is expedient that a square be used in order to have the belt perfectly in line longitudinally to insure correct running of the belt.

The glue or cement may be purchased from any of the mill furnishing houses upon application.

An oil burner is necessary in order to heat the glue whenever necessary, the glue and water to be heated until it is boiling, and about the thickness of cold maple malasses.

Apply while it is boiling to each side of the lap with a brush, and as expeditiously as it is possible, and with a piece of board about 2 or 3 inches wide press the joint down very quickly, and with some pressure, and leave it for about three hours for small belts, and six to ten hours for large belts providing it is in a warm, dry place.

It is not necessary to put tacks, pegs or anything in a glued joint, for when correctly done it is as strong as any part of the belt.

A correct joint for cementing is to have the lap just one inch longer than the width of the belt for all belts up to eight inches wide, and two inches for all over that width.

Any number of belts may be prepared and glued at the same time and left to dry over night when it is possible.

Belts to be glued while around a shaft can be nailed to the flour to be glued, but those that can be put on after gluing may be glued at the bench, or nailed to pieces of board.

When preparing the joints be careful to have the laps just so thick that the joint when completed will be of equal thickness to that of the belt itself.

For neatness, durability, cleanliness, power saving and noiseless running there is nothing that can compare with the cemented joint, and my advice to all operatives is to practice this method, and apply it to all belts, and when once tried always used.

Bailey's Adjustable Belt Plane is a good one for the dressing of the ends for cementing, and is inexpensive, and may be obtained at the mill furnishers.

Belt cement that is alright is that of LePage, and Schultz.

Lathrop's Patent Belt Awl is very useful for the lacing of belts.

There is nothing looks more pleasing to the eye of a competent miller when visiting a mill than to see all belts running correctly, neatly laced, and running straight on the pulleys, and just tight enough to do their work.

There is nothing more displeasing to the eye of a good miller than slovenly laced and crooked belting, running all ways but the correct way, and each belt with half a dozen laced joints instead of one, or a cement joint.

The rule for finding the horse power of leather belting:

Multiply the diameter of driving pulley, by the revolutions per minute, then by width of belt in inches, then by weight of belt in inches per square foot, and divide the quotient by the following for the sizes of pulleys being used.

45,000 for pulleys 47 inches up to 54.
48,000 for pulleys 35 to 45 inches.
50,000 for pulleys 23 to 33 inches.
54,000 for pulleys 14 to 23 inches.
58,000 for pulleys 5 to 12 inches.
60,000 for pulleys 4 to 10 inches.

4-ply rubber belting is equivalent to heavy single leather belting.

Example for finding the horse power of a 5-inch belt weighing 7 ounces per square foot, driving pulley 30 inches, running at 300 revolutions per minute.

$$\frac{5 \times 7 \times 30 \times 300}{50{,}000} = 6.30 \text{ horse power.}$$

When getting the length of belt required when pulleys are in place it is not such an easy task as it appears, and a string should never be used for that purpose, as it stretches very unevenly.

A steel tape measure is the best for this purpose, and a non-stretching measure is good, and after measuring exactly around the pulleys cut a new belt about six inches short for about twelve foot centers.

In the selection of leather belting be careful that each lap is not over 4 feet 7 inches, which is about the limit of the length of the back strip of cattle.

In buying belting it is the best of policy to get the best under a guarantee from the seller, for there is much money lost in buying belting, and so much shoddy stuff sold by unreliable firms.

Never use a double belt when a single may be used, for it is harder on bearings, takes more power, the outer lap travels further than the inner lap, consequently there is always a fearful strain on a large thick belt, and especially when passing over pulleys of small diameter.

Whenever possible have the slack side on top, and the pulling side below, and especially for driving belts, for it gives greatly increased adhesive power, is easier on the bearing, the belt may be run very slack, and it appears better.

When the slack is on the upper side and the belt is slack, it increases the adhesion of the belt by enlarging its circumferential contact with the pulley.

The amount of slack should be just sufficient to allow the belt to run with a gentle, undulating motion, and all the tension being on the pulling or under side, and while passing over the top the belt has time to rest and contract to its natural texture, which will prolong its life.

By running belting as slack as it is possible, it saves power, prolongs the life of the belt, saves wear and tear on the bearings, oil, and repairs.

Avoid tighteners whenever it is possible, and when impossible always place them at the slack side of the belt.

Vertical belts have to be drawn much tighter than horizontal ones, and they must have a slight spring, or the weight of the belt will cause it to lose its contact with the lower pulley.

When using idlers on vertical belts they should be placed close to the driving pulley as shown in Fig. 33, which is a very satisfactory drive.

I had to resort to this drive in the erection of a mill in South America, where I drove direct from the line shaft to the second counter shaft in the third story, and

Fig. 33.

was very satisfactory for the reason that it was above its power, and running over pulleys that were of sufficient size.

When using this style drive it is necessary to have the pulleys large, the belt slightly above the power required, when it will give no trouble whatever.

Long belts, horizontal and inclined ones are more satisfactory and economical than the vertical or short belts, as the latter have to be kept so tight that they are under continual strain.

It requires much more tension to prevent slipping on a high speed belt than it requires on a slow one, as the centrifugal force of a belt, acting against its tension, causes it to slacken its grip on the pulleys, and that force voluntary increases in direct proportion to its speed.

The sound reason for using a single belt in preference to that of a double one, is that the extra strength obtained is counterbalanced by its want of contact with the pulley, and the extra power to bend it, owing to its wants of pliability.

Never make a belt so tight that it requires two men to put a 7-inch belt on a pulley while in motion.

Be very careful not to allow a belt to slip, or the pulley becomes hot and burns the belt in a few seconds beyond all further use.

To measure belting in the coil or roll:

To the diameter of the outer coil, add the diameter of the inner coil in inches, and then by the number of coils, and lastly by decimal .1309, and the result is in feet in length, after dividing by 12.

The following gives a fair description of round belting, and in Fig. 34 is shown the method of its working contact with the surface of the grooves.

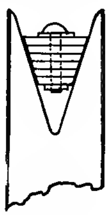


Fig. 34.

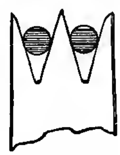


Fig. 35.

Round belting requires lighter shafting, less power, smaller holes in the floors, occupy less room, and are noiseless.

The grooves for round belting or rope drives must be of "V" shape as shown in cut 35 so that they fit snugly and without slipping, and which gives long life to the belt or rope.

The round belt or rope when running must touch the pulley in two lines only, tangential to the sides of the grooves.

In this way the friction of the band, and consequently its driving power increases in proportion to the decrease in the angle of the grooves.

In Fig. 36 is represented the Underwood Angular Belting when in motion.

The driving power of this belting is simply enormous.

Belts of sheet iron and steel have been run with satisfactory results.

Woven leather and leather link belting are used very extensively on dynamos and fast running machinery, and with good satisfaction.

This belting may be run on either side, and on account of displacing the air they hug the face of the pulley continually, and when running dynamos with the slack side above, it may be run so slack that the upper may touch the lower side while in motion and there will be no slipping.

There are many kinds of link belting, and they all with few exceptions run on the same principal.

Link belting should only be used in a flour mill on slow running machinery, or the annoyance from noise is great, and the loss of life and limb is very great.

This kind of belting should always run with the back of the coupling hook to the pulley.

If the belt is run on the other side it will soon wear off the ends of the hooks and fall to pieces.

This style of belting is very objectionable on account of the cripples it has made, and it should never be used, and an operative must be very careful when handling this belting while the machinery is in motion, or he may be torn to pieces.

This kind of belting must not be run too tight, and when it is it speaks for itself by a slip and a jar.

They require to be lubricated with thick oil or grease.

A tightener can be arranged to take up the slack on link belting by allowing an idler pulley to lean against the slack side of the chain, and where there is grit or sand use only plumbago.

The slack on the link belting is easily taken up by removing links when necessary.

TABLE FOR LINK BELTING.

Chain No.	Links Per Foot	Working Strain	Approximate in Leather Belting		
25	13.3	75	1	inch	single
32	10.4	150	1½	"	"
33	8.6	200	2	"	"
34	8.6	225	2½	"	"
35	7.4	250	2½	"	"
42	8.8	300	3	"	"
45	7.4	350	3½	"	"
51	10.4	375	3½	"	"
52	8.0	450	4	"	"
55	7.4	500	4	"	"
57	5.2	600	6	"	"
62	7.3	650	6½	"	"
66	6.0	700	6½	"	"
67	5.2	700	7	"	"
75	4.6	750	7½	"	"
77	3.3	800	8	"	"
78	4.6	1000	10	"	"
83	3.0	1200	12	"	"
85	3.0	1300	9	"	double
88	4.6	1200	8	"	"
93	3.0	1600	10	"	"
95	3.0	1600	10	"	"
103	4.0	1800	12	"	"
105	2.0	1500	10	"	"
106	2.0	1700	11	"	"
107	2.0	1600	10	"	"
108	2.55	2000	13	"	"
114	3.66	2000	13	"	"
122	2.0	2200	15	"	"
124	3.0	2250	17	"	"
146	2.0	2800	19	"	"
160	1.0	4000	....	"	"

Chapter XXII.

DRIVES, BY BELTS AND ROPES.

The different drives where belts can be applied are almost without number, and the place where they can not be used to advantage are very rare.

When laying out shafting it is very important that the drums and belts be arranged in such a manner that the stress on one journal may be counteracted by that of another belt working in an opposite direction.

It often happens that a driving shaft has to be placed at the side of the building, thereby placing the strain on that side, and this arrangement should be avoided whenever possible.

When pulleys of widely unequal diameter are connected by a belt, the contact on the small pulley is so reduced that the belt must be very tight to prevent slipping, and enable it to carry the load.

The Fig. 36 shows how it may be arranged without resorting to a countershaft, and by which a high speed may be reached.

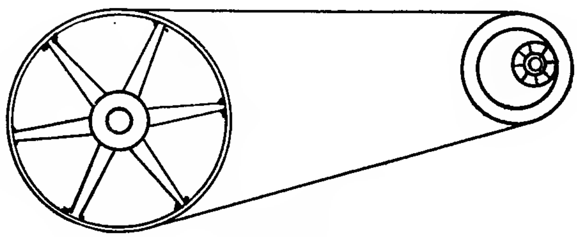


Fig. 36.

The smallest pulley is grooved and keyed into the shaft to which the high speed is to be communicated, and on it is placed a flexible ring as shown, of two or three times the diameter of the small pulley, and grooved inwardly to fit onto the small pulley, and the ring being smoothly turned on the outer side it gives the belt power to make the high speed without trouble.

The speed ring is held in place by the tension of the belt, and may only be used for small machinery with safety.

The drive represented in Fig. 37 is a very effective one, with any width of belt being available, and any force given off that is desired.

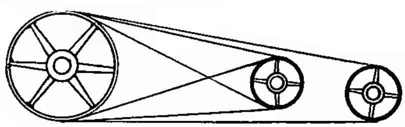


Fig. 37.

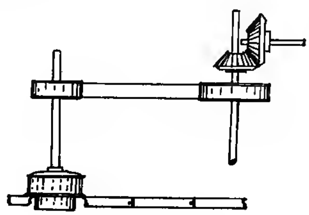


Fig. 38.

The large pulley is the driver and the smaller ones the driven. On the driving pulley the belts run one on the other, and the work done by this drive is very satisfactory indeed.

The inner belt may be run straight or crossed as shown.

In Fig. 38 is illustrated a very convenient drive that the author had to resort to

in order to reduce the speed of the line shaft and replace a pair of high speed spur gears that communicated the power from the turbine shaft, running at 450 revolutions, to the line shaft driving the rolls.

This drive is preferable to the quarter twist, it gives little trouble, and especially when each pulley is slightly convexed.

Rope drives. Rope drives are of two kinds, English and American.

The American drive is very convenient on account of its applicability to several shafts at the same time.

The great advantage of this drive is the great power, the small space occupied, its noiselessness, does not slip, and causes neither draft or electricity.

In Fig. 39 is given the English drive direct from the engine, and as you will see, it is made up of several single ropes, and when the stretch has been taken out of the ropes, it gives little trouble and is very effective and durable.

It is far from being the drive that the American is in appearance, neither is it applicable under such varied conditions.

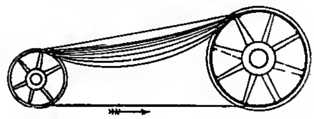


Fig. 39.

This drive is very convenient, is easy running, noiseless, takes little power for friction, it may be taken over more shafts than those shown in the illustration, and is very durable.

Manila or cotton ropes should not be exposed to the elements, grooved pulleys either, and when not preventable, the ropes must be loosened up, for dampness will cause tremendous shrinkage.

If the rope is running in wet atmosphere, the American drive will take care of itself by the automatic tightening arrangement, and the English drive generally has enough slack to allow for shrinkage.

The life of ropes depend upon the conditions under which they are working, such as overwork, rough grooves, small pulleys, change of temperature, and other forms of rough usage to which they are put.

Do not allow ropes to come in contact with stationary bodies, for the abrasion is very great, and the ropes do considerable jumping.

The grooves should not be too close or the ropes will touch each other between centers, causing abrasion and wear.

Do not put too heavy a strain on the tightener or it will make trouble by the journals heating.

There is one splendid redeeming feature to the English drive in not having to shut down when a rope breaks providing there is no entanglement by the broken rope, for the rest will carry the load until such time as the mill shuts down.

The tightener and guide on the American drive is automatic, allowing it to give and take, which keeps the journals cool, and saves power.

It is a pleasing sight to see the main drive of a large mill or factory with several strands of rope passing noiselessly over a large pulley, driving shaft after shaft, each with their load.

The ropes while running are scarcely noticable to the naked eye, and how much such a drive is to be preferred to that of a large, noisy belt, and especially when having to pass over idlers.

Rope drives do not cost as much as belt drives, and it seems strange they are not in more general use today.

To find the horsepower of a rope: Multiply half the diameter of the rope by the hundreds of feet it travels per minute, the quotient is the horsepower:

Manila rope 1 inch wide, running 1000 feet, gives 4.0 H. P.
Manila rope 1¼ inch wide, running 1000 feet, gives 6.0 H. P.
Manila rope 1½ inch wide, running 1000 feet, gives 9.0 H. P.
Manila rope 2 inch wide, running 1000 feet, gives 16.0 H. P.
Manila rope 2½ inch wide, running 1000 feet, gives 25.0 H. P.

WIRE ROPE DRIVES.

The groove is rubber filled, which adds to its frictional adhesion, and the rope should run at the base of the groove. When only used for hoisting, or similar purposes, they are not rubber filled. They are simply iron, or wood lined. It is practical to use wire rope for driving them, and it is cheaper than shafting and pulleys, especially when exposed to the weather, as they do not stretch very much.

The following table gives the comparative strength of wire and hemp rope:

IRON.

Trade No.	Diameter	Proper working load in tons of 2,000 pounds	Circumference of hemp rope of equal strength
11	1½	9	10¾
12	1⅜	7½	10
13	1¼	6¼	9¼
14	1⅛	5	8
15	1	4	7
16	⅞	3	6¼
17	¾	2¼	5¼
18	11/16	2	5
19	⅝	1½	4¾
20	9/16	1	4
21	½	¾	3¾
22	7/16	½	3¼
23	⅜	½	2½
24	5/16	½	2¼
25	9/32	½	2

CHAPTER XXIII.

QUARTER TWIST BELTS AND DRIVES.

When two shafts are at right angles to each other, or nearly so, and not in the same plane, and it is desired to drive one from the other by two pulleys only and a belt, certain conditions must be present. The distance of the near faces of the pulleys must not be nearer than four times the width of the belt.

The quarter twist is a very convenient drive in every case where the shafts are at right angles and in the same plane. It is applicable to small and large powers alike, but it is very hard on the belts.

The quarter twist must be so arranged that the belt will lead from the face of one for driving a mill from a vertical turbine shaft, where the speed is too high for exact position of the lines of contact. This drive is very often found to be a convenient one pulley to the center of the face of the other. The illustration at Fig. 48 show the gears.

The straight drive is preferable, on account of saving the belt. An idler may be used on this drive if required, but the strain on the belt is there, although somewhat relieved. The pulley from which the belt of the quarter twist deflects should be

wider on the face than the other one, in the proportion of six to eight, and more convexed. The pulleys for this peculiar drive should always be as small as possible, and nearly equal in size. The greater distance the drive, the lighter the side strain on the belt.

On the quarter-twist belt about 25 per cent. of actual contact is lost, even when the pulleys are of equal proportions. The employment of the idler, or guide pulley, will permit of a much shorter drive being used.

For shafts at right angles, but not in the same plane, the belt runs on four pulleys, two of them loose and two fast. The loose ones may be known by the collars. All the pulleys are the same size, and rounded on the face.

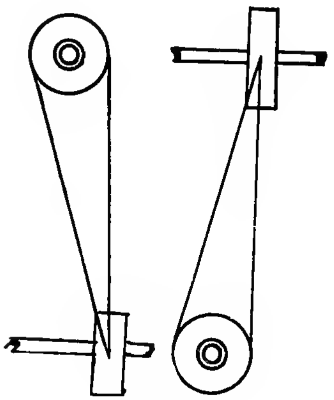


Fig. 40.

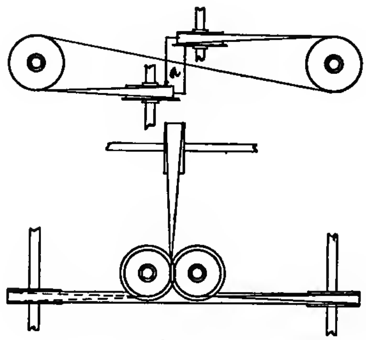


Fig. 41.

Fig. 41 gives a method of driving two shafts from one. The letter "a" indicates the driving pulley. The upright shafts have loose pulleys at right angles to the main shaft. The belt will run either way on both loose pulleys.

Two shafts placed at any angle with each other may be effectively driven by two belts, each having less than a one-eighth twist, and each running on two pulleys. This is done by placing counter shafts above or below and across the main lines at or near equal angles to the main line shafts.

In Fig. 42 is given the usual shop method of cutting belt holes.

To do this work draw on a level floor, as shown in Fig. 43, a full sized view of the position of the pulleys on the floor through which the belts will pass. Or the plan may be drawn to a scale, on paper. Observe that the fold of the belt leaving the face of one pulley approaches the center of the face of the other pulley in a line at right angles to the axis of the other.

Completing the figures of 42 the places where the lines pass the floor are where the centers of both folds of the belt will pass when drawn tight and at rest.

The obliquity of the opening can be ascertained by means of a tape line, placed as the belt ought to be when running. It is the part of wisdom, in order to do neat work, to allow the belt to be put in place before trimming the holes to a finish.

For cutting holes for straight belts lay out to scale the exact plan and arrangement of pulleys, their distances from floors, above and below, as the horizontal line, and from the wall, elevator leg, or plumb line for the vertical line, as shown in Fig. 44. In this instance the wall is thicker below than above which must be taken into consideration.

After laying out the scale which shows the belt in place, and where the lines pass the floor, the belt holes must be cut.

The same manner of laying out will answer the same purpose for cross belts.

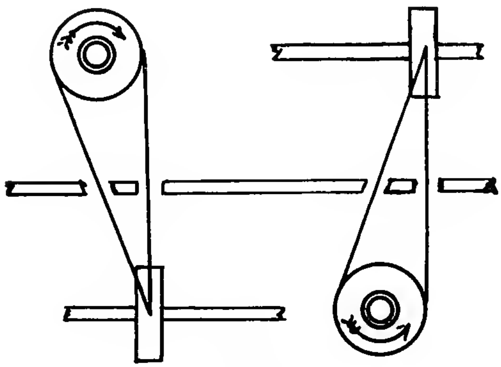


Fig. 42.

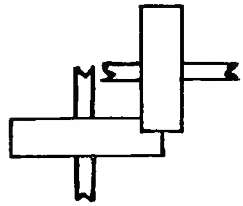


Fig. 43.

The writer is aware that the information given by him on many subjects is not absolutely necessary for an operative miller to know, but at the same time he realizes that it is good policy to have knowledge of such things.

An operative miller will often be placed in a position when it is very expensive to obtain a millwright, and many times it will happen to millers running mills in foreign lands when it is impossible to obtain one at any price.

The author, though not a millwright, has been placed in this predicament in foreign lands, and has had to plan mills, drives, hang shafting, line up machines, cut

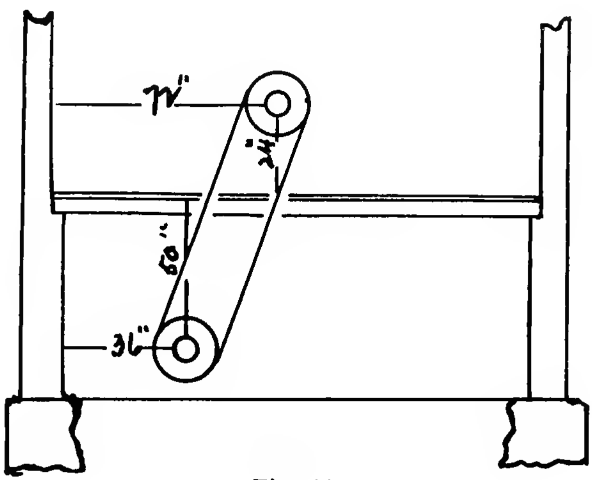


Fig. 44.

belt holes, and all kinds of construction work and building canals, and if I had not have known, the loss of time and money would have run up into the thousands of dollars.

A miller may be a superior miller by having the knowledge of millwrighting, and

a millwright will in all probability be a better millwright by understanding milling; and I do know that he will be better fitted to put up spouting that will allow the stock to pass through them.

There are times when a headmiller will be called upon to diagram, plan, etc., when changes are necessary, and it will place him in a peculiar position with his understudies should he be ignorant of such matters.

There are many millers that laugh and jeer at a miller-millwright and vice versa, but allow them to laugh, for they will make less failures I warrant you than those knowing nothing about millwrighting.

Good fortune generally comes to the one seeking after knowledge.

Chapter XXIV.

GEARS AND GEAR DRIVING.

Gear wheels are known to the trade under the following names: Bevel gear, mortise bevel gear, spur gear, spur mortise gear, internal spur gear, and miter gear.

Fig. 45 gives an illustration of bevel gear wheels. which gives the greatest pitch diameter.

It is very important that wheels and pulleys of all kinds be of accurate balance, or springing shafts, shaking buildings, etc., will be the result.

Bevel gears are often run iron to iron, but are very noisy. Bevelled iron and bevelled mortised are preferable, running together, as they run very smoothly if directly in line.

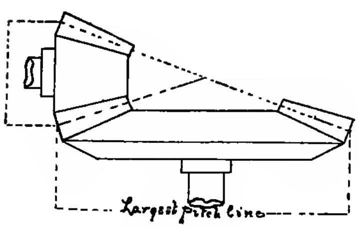


Fig. 45.

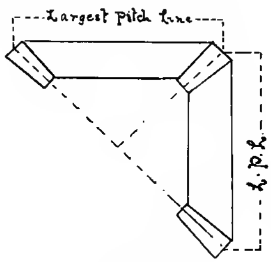


Fig. 46.

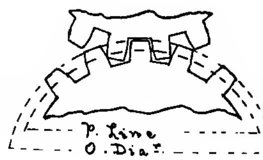


Fig. 47.

Mortise bevel gear have wooden cogs, and are run iron against wood, the driving wheel of iron, the driven of wood.

Fig. 46 shows the miter gear form of wheel, and the largest pitch diameter.

These wheels are generally placed so as to reverse the motion.

Fig. 47 shows the form and pitch diameter of spur gear wheels. They are sometimes used on rolls, burrs, shafting, etc., but are very objectionable on fast running machinery, on account of the tremendous jar and noise.

Spur mortise gear wheels have modern cogs, which are made out of hard sugar maple, hickory, or any close-grained hard wood.

At Fig. 48 is shown the internal spur gear, which is often used to reduce or increase the speed of machinery.

Bevel drives on all gears are not used as often as formerly. Bevel gear is used mostly on turbines, and is a very convenient drive where the speed is not greater than 350 revolutions per minute, but below 300 is preferable.

Fig. 49 illustrates a drive for bevel gear from turbine, continued into the mill, on the several floors.

It was formerly a common practice to run a shaft into the mill and drive an upright with spur gear. Fig. 50 represents the spur gear driving shafting, and reducing speed generally.

Cog wheels of all kinds ought to be thoroughly dressed on the cogs. Iron teeth are best when machine cut. Wooden cogs must be well seasoned before being put in. They must be at equal distances apart, smoothly trimmed, well wedged and kept so. They must be well greased with fat and black lead to keep them from wearing, and to save power.

When setting them for running it is best to allow one-eighth to one-quarter of an inch play, so that if they do get out of line suddenly, they are free to go either way. They will also run with less jar. Great care should be exercised to have them in perfect tooth alignment, or the power is all on one point, causing rapid wear.

The pitch line of bevel gear is as nearly as possible in the center of the cogs.

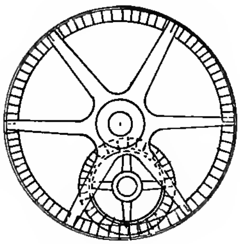


Fig. 48.

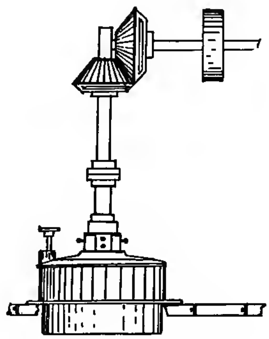


Fig. 49.

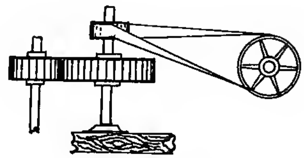


Fig. 50.

Divide the length of the cog into seven parts. Three of the parts will represent the distance from the point of the cog to the pitch line, and the other four parts will show the distance from the pitch line to the base of the cog.

Cog wheels of every description may be made of iron, steel, case hardened steel, brass, gun metal, paper, rawhide, cloth, etc.

The variety of gear wheels are many, and I give them as I have known them, and have had experience with them.

Bevel gear, mortise bevel gear, miter gear, spur gear, skew bevel gear, spur stone gear, internal gear, helical gear, worm gear, spur mortise gear, paper friction gear, iron friction gear.

To find the horse power of gears.

Multiply the diameter of spur gear, or average diameter of bevel or miter gear by pitch of teeth in inches, by width of teeth in inches; and again revolutions per minute.

Horse power equals diameter X pitch X face X revolutions ÷ 550.

Example: 20 inch miter gear, 2 inch pitch, 5 inch face, 40 revolutions per minute.

Average diameter 16 inches.

$$\frac{16 \times 2 \times 5 \times 40}{550} = 11.60 \text{ horse power.}$$

It is usual to make the tooth equal to 0.475 of the pitch for iron gears; and the pinion tooth for wood and iron gears equal to 0.3585 of the pitch. The horse power of iron gears equals .00148 multiplied by the face; then multiplied by the pitch, again by the diameter, and lastly by the revolutions per minute.

The horse power of mortise gear equals .00085, multiplied by the face, then by the pitch, again by the diameter, and lastly by the revolutions per minute.

The face, pitch and diameter should be in inches in order to make these calculations.

To find the speed of gears, the teeth of the driven must be known in order to

find its revolutions. Multiply the number of cogs in the driver by its revolutions per minute, and divide by the number of cogs in the driven.

The teeth and speed of driven being known, to find the number of teeth required in driver, multply the teeth in driven by its revolutions, and divide the product by the number of revolutions of the driving shaft, and the quotient is the number of teeth required in the driver.

The teeth of the driver being given, to find the teeth required in the driven, multiply the number of teeth in the driver by its revolutions per minute, and divide by the speed of the driven. The quotient is the number of teeth of the driven.

Chapter XXV.

SHAFTING.

There are three general conditions under which shafting is used, varying in liability to unexpected strains, so that the safety factors must be modified somewhat with the conditions.

For first shafts, prime mover or jack shafts, subject to the strain of heavy pulleys or gears, allowing a safety factor of 15, and assuming the breaking strain of wrought iron at 56,000 pounds per square inch, the horse power equals 0.01 multiplied by the cube of the diameter, multiplied by the number of revolutions per minute.

Long lines and second mover, transmitting power, a safety factor of 7½ is allowed. The horse power equals 0.03 multiplied by the cube of the diameter, multiplied by the number of revolutions per minute.

For third mover, or countershafts well supported, a safety factor of 5 is allowed. The horse power equals 0.03 multiplied by the cube of the diameter, multiplied by the number of revolutions per minute.

A cast iron shaft to be of equal power must be 1.185 the diameter of the wrought iron shaft.

A steel shaft of equal power is 0.850 the diameter of the wrought iron.

Bearings should be made long and adjustable, and should be in length about four times the diameter of the shaft, up to a certain diameter.

Nothing looks better than a long lineshaft, with all its different sized pulleys painted a bright color, and the shaft as clean and brilliant as a star, and in perfect alignment. On the other hand, nothing looks more disgusting on going into a mill or shop than to see a line of shafting covered with grease from end to end, its motion like the waves of the sea because of being out of line, or having faulty couplings, and unbalanced pulleys, some of which are wood and not centered.

Keep a shaft bright, as it costs but little to clean it when in motion, and is a factor of safety to human life, and may often add to the life of a belt.

When putting on pulleys, if it is necessary to put two closer together than the width of the belts running on them, put on a guard to prevent the belt falling between them, as otherwise it may result in a bent shaft, broken machine and belts, and possibly loss of life.

Have shafting small as possible and run it at high speed rather than use larger shafting at less speed, as extra weight means extra friction, and therefore more power. Do not have them too small, however, for they might be all right when up to speed, but not when starting up, as the strain then is very great.

Too much attention cannot be paid to the alignment of shafting. There are various ways of lining a shaft. Long lines of shafting are difficult to put in perfect alignment, and as carpenter's tools are not reliable enough, an engineer's transit ought to be used. The floor lines can be used to good advantage in this work, and by the judicious use of a good spirit level, it can be made perfectly level. Every shaft must be kept in line with the main and prime mover shafts.

Shafting may be in perfect line when starting a new mill; but can soon get out

of line by the settling of the building, warping of the timbers, and various other causes.

It takes much additional power to run shafting when out of line, and often causes a breakage. The writer has at various times found shafting several inches out of line.

When putting in new and heavy machinery, changing foundations, storing goods, etc., in a building, the shafting needs very close attention.

When a line of shafting is in perfect alignment, it may be easily turned with the hands, simply grasping the shaft.

It is important that care be exercised in coupling a shaft to prevent its wobbling and breaking. No coupling has given more general satisfaction than the plate coupling, with bolt heads and nuts countersunk. They are about as cheap as any, and none look better.

Vertical shafting requires a great deal of attention, as it is much more apt to get out of line than the horizontal. Always be very careful to keep them bright, as many deaths have resulted from dresses and coats being caught when the wearers were merely walking by them.

Clutch couplings are made in various forms. The compression clutch is a very good one. These clutches are almost indispensible in a mill for connecting machinery that only has to run a part of the time, so that it can be thrown in and out of operation at will.

The following table shows the horse power that can be safely transmitted by well constructed wrought iron shafting. For steel shafting, add 60 per cent.; for cast iron shafting, deduct 40 per cent.:

Diameter of Shafting	REVOLUTIONS PER MINUTE 50	75	100	150	200	300	400
11/16	.50	.75	1.00	1.50	2.00	3.00	4.00
1 11/16	1.70	2.55	3.35	5.05	6.75	10.10	13.50
2 3/16	4.00	6.00	8.00	12.00	16.00	24.00	32.00
2 7/16	7.80	11.20	15.60	23.40	31.24	46.86	62.48
2 15/16	13.50	20.25	27.00	40.50	54.00	81.00	108.00
3 7/16	21.44	32.16	42.87	64.30	85.75	128.60	171.48
3 15/16	32.00	48.00	64.00	96.00	128.00	192.00	256.00
4 7/16	44.78	67.55	91.12	135.90	182.24	273.36	364.48
4 15/16	62.50	93.75	125.00	187.50	250.00	375.00	500.00
5 7/16	83.10	124.28	166.37	249.56	332.74	499.11	665.48
5 15/16	103.00	157.00	216.00	319.00	432.00	648.00	864.00
6 15/16	171.50	257.25	343.00	514.50	686.00	1029.00	1372.00
10 7/16	500.00	750.00	1000.00	1500.00	2000.00	3000.00	4000.00
14 15/16	750.00	1125.00	1500.00	2250.00	3000.00	4500.00	6000.00
19 15/16	1000.00	1500.00	2000.00	3000.00	4000.00	6000.00	8000.00

For any number of revolutions not found in the table, multiply the horse power given for 100 revolutions by the number of revolutions required, and divide by 100.

Alinging shafting, also leveling may be done in several different ways, and it is always well to get the first line from the main lineshaft after it has been lined from the engine or prime mover.

After the first line is on the floor where the line shaft must go, a line may be stretched very tight at the height the shaft is to be hung.

The line can be hung from two cross arms that are of equal height from the floor by actual measurement; and it is best to have those cross arms a little further apart than the actual length of the shaft.

After the line is stretched a plumb line may be hung from it to the floor line and moved along it until it is in perfect alignment to the floor line.

The aligning line may be moved on the cross arms either way at will until it is in line with the floor line.

As soon as the aligning line is in line with the floor line the shaft can be hung by it, by putting up the bearing exactly by the aligning line.

After the shaft is hung it may be proven by dropping a line over the side of the shaft to the floor line, making correct allowance for the various thicknesses of the shaft.

After the shaft is hung it can be tried regarding being level and corrected.

When leveling a shaft it is well to place the level between the bearings on account of sag, and also at the bearing after the cap has been removed.

When necessary to align shafting already hung the plumb line may be dropped over the side of the shaft to the floor line.

To level a shaft by the bearings it is necessary to have a straight edge that is long enough to reach from bearing to bearing.

Shafting may be cleaned and polished by hanging something on it or against it while in motion, which by the constant friction will brighten it.

It has been done by holding a sack against the shaft, but that is very dangerous to the operator, for it is apt to get caught and entangle the person doing it.

Chapter XXVI.

PULLEYS.

Two kinds of pulleys are in general use at the present time, wood and iron.

The wood pulleys are very good when they are properly made and balanced, and have a smooth face. They are made in sections or halves, and can be put on in segments or whole, as desired.

For general use there is nothing better than a fine machine-moulded cast iron pulley, with a smooth and slightly crowned face. However, they must be well cast, well balanced, and made according to the load they are to drive.

Avoid the use of split pulleys as much as possible, as they are heavier, and look clumsy when running.

Pulleys that have a heavy load to drive should have a key, and this should be held down with a good dished set screw or two.

It is good policy to have pulleys well fastened, for it is annoying when one becomes loose and the mill has to be shut down, and besides, the damage to the shaft by the set screws is often very great.

It is unpleasant to have to work in a mill having a constant jar, and nothing will cause a jar quicker than a lot of unbalanced pulleys.

Set screws are unreliable and dangerous for fastening pulleys. A good straight machine-moulded pulley, keyed and key cut off level with the hub is perfectly safe on the fastest running shafting.

In all the writer's milling experience he was never caught by the machinery but once, and that was by a set screw. It was necessary to put two belts on one pulley, when the mill started, and on account of its location he had to lean over a shaft. A set screw caught in his coat pocket, but being near the roof he was able to permit it to tear the coat, and thus perhaps saved his life.

Putting on belts is particularly dangerous in mills that are so crowded as not to allow a man the position desired. Always put a belt on the running pulley, when possible. Be on the lookout at all times for a lapping belt, for if it has a high speed, the man it catches will stand but a poor show for his life. It is an easy matter to put a belt on a running pulley if one knows how. One does not wonder at so many being caught when he sees how some, who call themselves competent men, try to do it.

The proper way is to push the belt onto the face of the pulley until it is tight. Always be on the side at which the belt is being applied, if possible, and give it a strong, quick push. In putting a belt on a fast-running pulley, it is well to use a small piece of wood, holding it against the belt until it gets a little motion. Do not work around a belt, however, with a piece of wood longer than nine inches, for it is very dangerous.

In putting belts on running pulleys, the conditions vary with every location, so that a man can hardly learn the best and safest methods other than by practice.

To determine the centrifugal strain of pulleys, multiply the square of the velocity of the rim in feet per second by its weight, and divide by 32 times the radius in feet. The quotient is the centrifugal strain in pounds. If the quotient be again divided by the sectional area of the rim in inches, it will give the strain upon the rim in pounds per square inch.

When using fast and loose pulleys as twins for shifting belts, they should both have a convex face. This will save annoyance by preventing the belt from working back.

The part of shifting lever which comes in contact with the belt, should be round and smooth, or made to revolve. Clutch pulleys are preferable, being quicker to act.

Loose pulleys must be kept perfectly lubricated, or they will be a source of annoyance. When oiled, they give no trouble whatever. The writer has known them to run for five years without trouble.

Belts up to eight inches wide may be put on the pulley by hand upon starting. If one should prove to be too tight to manage alone and there is no assistants available, put it as far around the pulley as possible. At the point where it leaves the face of the pulley, place a string, doubled so as to form a loop at one end; pass it around the belt and rim of pulley, pass the ends of the string through the loop and pull it up tight. You can hold the end when the mill starts, and it will slip out of the loop when the belt commences to move. Do not make any knot unless the string is weak enough to break readily. It is all right to tie the string if good judgment is uesd, for a pretty small string will put a belt on.

Belts larger than eight inches ought to be tightened by the use of a belt clamp, although the writer has easily put on 12-inch belts by hand. Be careful to have the belt on the opposite rim turned inside to the pulley, or it will be much harder to put on, and often will not go on at all unless it is so turned, and it may cut the belt at the one edge.

When ordering pulleys it is necessary to state diameter, face, "crowned or straight," size of bore, set screw or keyed, and if for single or double belt.

For none shifting belts the pulleys should have crowned faces, and for shifting belts the driving pulleys should have straight or flat faces.

Example for ordering pulleys:

10-inch diameter, 5-inch straight face, 2-15/16-inch bore, with key set, double belt, or

30-inch diameter, 6-inch crown face, 3-15/16-inch bore, set screw, single belt.

Crowned pulleys are always more satisfactory for the reason that the shafting may be slightly out of line and the belts will still run true, but with straight faces the belts will invariably run to one side or the other.

There is one drawback to the use of solid cast iron pulleys, and that is the inconvenience they cause when they break by having to wait for another.

The wood pulley has many advantages, and the greatest of them all is the split arrangement, allow the putting on and taking off at will.

Another advantage is the absence of set screws or keys to mar the shafting and endanger the workmen.

Another point in their favor is almost double the frictional contact to that of cast iron.

The wooden pulley saves power by their weight; they save in weight of hangers, shafting, etc.; they save in power required in overcoming the friction in the bearings by less weight of material in construction.

Wood pulleys may be run at a much higher speed than iron pulley, and with no danger of bursting with too high centrifugal force.

There is, however, a limit to the size of wood pulleys, and should not be used over 65 inches unless they are specially constructed.

Chapter XXVII.

BEARINGS.

There are many styles of bearings, boxes, or journals—whichever you may please to term them— such as the ball and socket, rigid, double adjustable, ring oiling, pillow block, rigid post box, adjustable post box, plain bearings, vertical bearings, ball bearings, step bearings, etc.

Of all the bearings thus far invented, none run cooler or more economically than the ball bearings, especially where there is a constant and heavy pressure as on a roller mill. For high speed machinery it is equally effective. It is very economical, as it does not waste oil to anywhere near the extent that all other bearings do.

Beneath the ring oiling bearing proper is the oil well. Passing around the shaft are two rings, of one-third greater circumference than the shaft. The shaft keeps the rings revolving, and as their lower parts run in the oil, it is fed onto the shaft constantly, thereby insuring perfect lubrication. For large bearings, the rings are perforated so as to carry a larger supply of oil.

Ball and socket boxes when thoroughly lubricated and under a medium load and pressure per square inch, are good workers.

The finest workmanship and accuracy is requisite in the making of the ball bearings,

The construction of this journal consists of a hardened steel collar, in the outer surface is a concave track finely polished steel ball travel.

Both the balls and the collar rotate with the revolving shaft, and they are kept in position by another collar having a concave track in the inner side.

The movement of the outer collar is independent of the balls of the inner collar.

There is no bearing that is so economical as the ball bearing, and the writer has seen a string 1/32 of an inch driving a 9 x 30 roll at 6 feet center to center, showing that the friction was almost nothing.

There is no bearing that is so economical in the use of lubricating matter as the ball bearing, and a gallon would almost serve a year to the bearing.

Another very economical bearing is the collar oiling bearing, and which is run on almost the same principal as the ring and chain oiling bearings.

The bearings simply work in a well of oil, making it, next to the modern ball bearing, the best in the world.

Adjustable post boxes are excellent for line shafting when erected by skilled millwrights.

The chain oiling bearing is an excellent one, and is an improvement over the ring oiler in that it has a detachable pan for holding and catching the oil, which permits of its being cleaned, and the oil filtered at will. They run perfectly cool, and require re-oiling only once in a long time. By running a mill on these chain oilers, a large percentage of power will be saved.

Bearings are generally made of brass, gun metal, or babbitt metal, more commonly the latter. For light slow speed shafts a good bearing is sometimes made of lignum vitae, also of a very hard wood grown in South America, called litre, which is of an oily nature, and exceedingly durable.

Always have a bearing long enough, and adjustable if possible. It is a good practice to have the length of the bearing equivalent to four times the diameter of the shaft it carries.

The bearing should always be large enough to allow the lubricant to circulate freely.

On line shafting bearings the caps should not be tightened to excess, as the shafts will bend between journals, and ought to have a little play at the bearings.

When using rigid bearings, watch them closely so as to keep them in perfect alignment, as one end is liable to drop, thus cutting the shaft, and causing the journal to heat.

It is well to inspect plain bearings very closely to see that they fit the shaft correctly, or they take much unnecessary power.

Tight bearings, tight belts, shafts out of line, bearings out of line, and hot journals are sources of power waste.

The roller bearings for roller mills are really passing the experimental stages for the reason that they have been too small for the tremendous pressure placed upon them; but there is no reason why they can not be constructed to withstand great pressure.

When bearings are in perfect alignment, the shafting working in them the same, and with small amount of play, and well lubricated, there is small amount of trouble with them.

CHAPTER XXVIII.

POWER.

A tremendous significance lies in the word "power." It is what has made modern industrial progress possible, and today nations are rich and progressive in proportion to the actual power applied to man's purposes. While men and beasts may be used as sources of power, and that useful animal, the horse, has allied his name with measure of power, the world is getting away from flesh and blood as sources of mere force, and placing the burdens borne by men and animals upon the engine, the turbine, and the windmill.

The steam engine, as a rule can be relied upon at all times when needed. Of course the locality has a great deal to do with the steady working of any motive power. When coal is used, circumstances occasionally intervene and stop the supply, such as strikes, damage to railroads, etc., which causes the engine to stand idle. Wood is used for fuel in many parts of the United States, and its economy depends upon the locality. In some places it may be had at $2.00 a cord for four-foot split wood, while in other localities it costs from $4.00 to $7.00 per cord, which places it out of the reach of the mill engineer as fuel.

In many places crude oil is in extensive use, but has not proved satisfactory in the majority of cases. It is a very convenient stoker when properly arranged, which is generally to supply it to the boilers by the force of steam. It causes a terrific noise, louder than the fiercest storm off Cape Horn, but improvements will remedy this objectionable feature.

A miller should be familiar with all the forms of power for driving mills, and it should be his duty to always work his mill so as to use the least amount of power possible. Every extra horse power means a good deal in one year, and the writer has known millers to use from 5 to 8 cents per barrel of flour for fuel, while others used from 3 to 5 cents per barrel.

Of the many kinds of engines in use, none has so far been so convenient, economical, and easily attached as the best types of the Corliss. There are many mills today that are making a barrel of flour for less than 3 cents for fuel, which is a record that is hard to beat.

The first requisite in a steam plant is the purchase of a good engine from a reliable firm; the next a thoroughly competent man to set it up and start it with a guarantee, and to see that it is accepted on its merits, instead of through a golden bait; and lastly, to be put into the hands of a certified engineer who is of good bait; and lastly, to be put into the hands of a certificated engineer who is of good character, and has a record for economy. If the plant be large, such a man is cheap if you pay him $2,000 yearly. Do not keep a man who is always half or fully drunk, a growler, or one who is always somewhere else instead of in the engine room, for if in charge of a large plant he would be expensive if he paid the owner $2,000 per year for the privilege of working. The same rule holds good in any case where men are in charge of manufacturing establishments.

Coal of a fair quality will be equal in heating power to about 80 per cent. of its weight in pure carbon.

When the engine and boilers are not in the hands of a competent and careful man, both employes, proprietor, and all connected with the establishment are in daily hazard. Of boiler explosions, fully 95 per cent. are from carelessness and ignorance.

The boiler ought to be inspected frequently, especially where the water is of a nature to produce scale.

When getting up steam, especially in cold weather, do not rush matters, as the most destructive explosions occur from this cause.

Be sure of your water. Do not trust to the gauge, but blow it out at intervals, as it is liable to choke at any time and thus mislead the engineer.

The sudden contraction and expansion of boilers is the greatest source of danger. Do not blow the boiler out and fill it up with cold water immediately. Wait until it is thoroughly cool. The bed bricks as well should also be cooled off.

Filling the boiler, firing the furnace, and getting up steam are very important matters and should not be left entirely to a fireman unless he be a practical man, thoroughly reliable, and alive to possible dangers.

Before getting up steam it is a good plan to raise the safety valve and let the accumulated air escape. It may be lowered when the water is warm.

Forced firing is injurious alike both to boiler and setting.

Keep an even fire not exceeding 8 inches in thickness. Fire systematically, and keep the fire bright, and you will not be annoyed by dense smoke, or with sending the larger share of the fuel up the smoke-stack.

Never mind which of the two principles of firing you go on; "spread" or "side" firing are equally efficacious if correctly done.

Automatic stokers are very economical and up to date plants are adopting them.

HORSE POWER OF ENGINES.

Rule for nominal horse power.—Square the diameter of the cylinder and divide the product by 4. Thus, $6 \times 6 = 36$; divided by $4 = 9$. Or, 10×10 divided by $4 = 25$; which are average ratings of six and ten-inch engines.

Indicated horse power is that imparted by the steam to the piston, and is a measure of the efficient action of the steam. It takes into consideration the defect of construction and results of wear, and is the only available method of making a comparison of performance of engines.

Rule.—Multiply the area of piston in square inches, by the average pressure of steam in pounds per square inch upon the piston throughout the stroke, and this by the piston velocity in feet per minute; divide this product by 33,000 and the result will be the horse power.

Actual horse power is the power of an engine available for efficient work, and is equal to the indicated horse power less all resistance of friction occurring in the engine itself. It will approximate 88 per cent. of the indicated horse power.

The steam engine indicator is necessary in order to make a diagram from which the average steam pressure is calculated.

ESTIMATING POWER OF STEAM BOILER.

Ten feet of heating surface will produce one horse power. The heating surface is two-thirds the surface of the cylinder and is obtained by multiplying the length by two-thirds of the circumference.

Flue boiler.—Fifteen feet of heating surface will produce one horse power. The heating surface is two-thirds the surface of the cylinder; also, the entire surface of all the flues.

Tubular boiler.—Fifteen feet of heating surface will produce one horse power. The heating surface is two-thirds the surface of the cylinder; also, the entire surface of the tubes.

Each nominal horse power will require one cubic foot of water per hour. One cubic foot of water contains 7½ gallons.

Speed of pump.—The ordnary speed at which to run a pump is 100 feet of piston per minute.

To find the area of a piston, square the diameter and multiply by .7854.

A gallon of water U. S. Standard weighs 8-1/3 pounds and contains 231 cubic inches.

A cubic foot of water weighs 62½ pounds and contains 1728 cubic inches or 7½ gallons.

Water and fire-proof cement.—Take pulverized litharge five pounds, fine Paris White two pounds, yellow ocher two ounces, hemp cut into shreds ½ ounce, and mix to a density of putty with boiled linseed oil.

The unit of power is one pound raised one foot in one minute.

Horse power.—A horse power is equivalent to raising one pound 33,000 feet high in one minute, or raising 33,000 pounds one foot high in one minute.

Horse power is generally associated with three qualifications: viz., indicated, effective and nominal horse power.

Steam is a very good servant but a bad master, neglect it and the results may be very disastrous.

It is very poor policy to be standing around an engine room unless it is absolutely certain that all is well with the boiler, for in one second all in connection therewith may be blown into eternity.

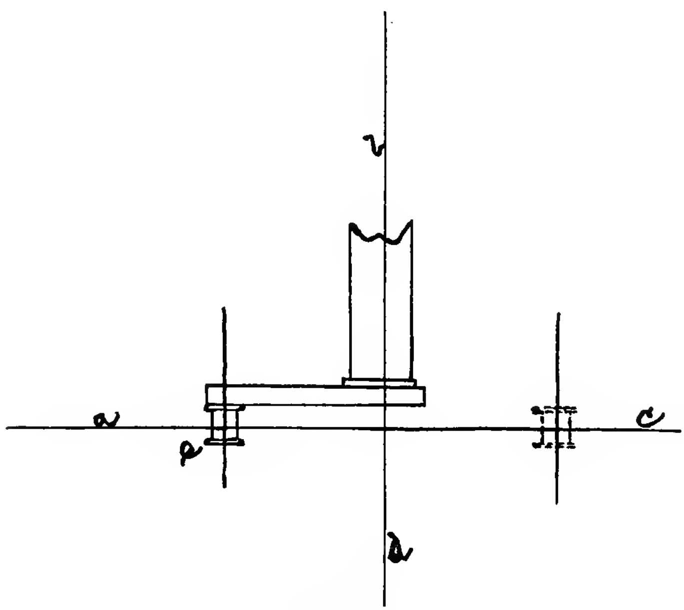


Fig. 51.

Never forget that there are hundreds of horse power in the boiler that is waiting to be let loose, and should that loosening of that power come by way of an explosion, woe to all persons that may be near.

It is the duty of the stoker to keep the fires as bright as possible, and free from clinkers to insure uniform and economical working of the engine and the mill.

Perfect combustion is the main object of all good and true engineers, and firemen, also the evaporation of the least amount of water per horse power consumed.

Keeping the fire bright means perfect combustion, as it consumes all the smoke, and not allowing any grease to go to waste.

Boiling point of water.	Freezing point.
Fahrenheit equals 212 degrees.	Fahrenheit equals 32 degrees.
Centegrade equals 100 degrees.	Centegrade equals 0 degrees.
Reaumer equals 80 degrees.	Reaumer equals 0 degrees.

In Fig. 51 is illustrated the method of obtaining the square of the engine by the main line shaft, or the main line shaft may be squared by the engine.

The line *a* and *c* is that through the cylinder, and *b* and *d* the main shaft line, and the one must be perfectly square with the other.

The crank at *e* line must turn over and meet crank line at *f* perfectly, or there is something out of order.

Be sure that the engine is perfectly level by the shaft and cylinder, or it will not line up as it ought to do.

The gas producing engine is coming into more general use today on account of its economical power, and should they become cheaper in first cost they would come into more general use.

The gas and gasoline engines are used very extensively, and give very good service.

The electric motor is one of the best, and the handiest power for small millls and elevators, for they are ready at all times, no fires to kindle, no cracking, no heating, no engineer, and just to turn on the switch and away its goes.

Whatever power you get have a man in charge that really understands it, or at any rate a man of mechanical ability, or there is generally trouble all around.

Chapter XXIX.

THE POWER OF WATER, OVERSHOTS, ETC.

To determine the power of water, two factors are necessary, both of which are very important. The power of a stream varies directly as the head or fall, and the quantity of water. The head is considered the difference of level between the surface of water in the head and tail race. Take the measurement of the head while the water is flowing through the channels.

Before building a mill which has to be driven by a certain stream, be sure that there is sufficient power necessary for the work required. It is best to have a reliable man to measure and ascertain the exact power of the water. After the actual power of the water is known, allow a loss of fifteen to twenty-five per cent. for friction, etc. For accuracy in measuring a stream of water a weir is necessary. Get the exact depth of the water about three feet above the weir. The most expeditious means of ascertaining the depth, and as nearly as any ordinary circumstances require it, is to take the depth every two feet, from side to side, and strike the average, which is near enough. Allow twenty-five per cent. off the actual horse power of the water.

The fall may be ascertained by any kind of a level if the wheel is near the source of head water. But if the wheel is at a distance an engineer or other reliable man ought to level the canal.

Large streams can not be measured by weirs, and other means must be resorted to. If the stream is too deep to wade across get a boat or raft, and take the depth in about half a dozen places, and strike the average.

The course to pursue, and one of great importance, is to obtain the mean velocity of the water in the stream. Find a part of the stream where the water is moving very smoothly, and where the banks are even and nearly perpendicular. Mark off about three sections of 100 or 200 feet each, each section to be marked by placing a string across the stream. Take a submerged float, a long bottle sunk to the cork is good, and put it into the water at the highest mark, or a little above, so as to get up to speed before reaching the mark. Note the exact time it occupies between each mark, and

take the average. It is best to do this several times, putting the float in different parts of the stream. A man measuring a stream must use good judgment, and he will understand if he has obtained the approximate mean velocity.

Take the number of soundings, add them, and divide the sum by the number of soundings, and the quotient is the mean depth of the stream. The mean velocity of a stream is eighty per cent. of the surface velocity approximately.

To ascertain the volume of water, multiply the mean depth by the width of the stream in feet, and the product by the mean velocity in feet per minute, and the quotient is the volume of water.

To find the horse power of a stream, multiply the volume of water by 62½ pounds, then multiply again by the head or fall in feet, which will give the foot pounds for stream, this product divided by 33,000 foot pounds will give the theoretical horse power.

A cubic foot of fresh water weighs 62½ pounds, a cubic foot of salt water 64 pounds.

The useful effect of the turbine and overshot water wheels of the most modern type, and under the most favorable conditions, is about eighty per cent.

A cubic foot of water is 1,728 cubic inches, or 7½ gallons.

To find the pressure on each square inch multiply the head in feet by .434, or divide by 2.30. Each 2.30 feet in height increases the pressure one pound.

The following table gives the approximate flow over each inch in length of a sharp crested weir. It does not take into consideration the end contraction, which is very small:

WEIR TABLE.

FLOW FOR EACH INCH IN WIDTH.

Inches		⅛	¼	⅜	½	⅝	¾	⅞	**Inches**
1	.40	.47	.55	.65	.74	.83	.93	1.03	1
2	1.14	1.24	1.36	1.47	1.59	1.71	1.83	1.96	2
3	2.09	2.23	2.36	2.50	2.63	2.78	2.92	3.07	3
4	3.22	3.37	3.52	3.68	3.83	3.99	4.16	4.32	4
5	4.50	4.67	4.84	5.01	5.18	5.36	5.54	5.72	5
6	5.90	6.09	6.28	6.47	6.65	6.85	7.05	7.25	6
7	10.86	7.64	7.84	8.05	8.25	8.45	8.66	8.86	7
8	12.71	9.31	9.52	9.74	9.96	10.18	10.40	10.62	8
9	14.67	10.08	11.31	11.54	11.77	12.00	12.23	12.47	9
10	16.73	13.95	13.19	13.43	13.67	13.93	14.16	14.42	10

To find the horse power of a stream. Example in arithmetical form. 700 cubic feet of water per minute, by 62½ or 62.50 by 50 the height of the fall in feet, and divided by 33,000.

$$\frac{700 \times 62.50 \times 50}{33{,}000} = 62.20 \text{ horse power.}$$

MEASUREMENT OF WATER ON OVERSHOTS.

The mean velocity of a jet at its minimum section is .974 of the theoretical velocity, and the section of a jet at this point of maximum contraction is .637 of the measurement of the orifice.

Table giving discharge and velocity of water from an orifice, under various heads, from two to thirty inches:

Head in inches to center of orifice	Theoretical velocity in feet per second	Efflux or outflow
2	3.27	0.87
4	4.63	1.20
6	5.67	1.46
8	6.53	1.70
10	7.32	1.89
12	8.02	2.07
14	8.66	2.24
16	9.26	2.40
18	9.82	2.55
20	10.37	2.68
22	10.86	2.81
24	11.34	2.93
26	11.81	3.05
28	12.27	3.16
30	12.69	3.28

The actual discharge of the foregoing table is 62 per cent. of the theoretical discharge, and the total power of the water actually discharged.

The cubic feet of water running on overshot, multiplied by the head in feet, "measured from the level of the water in the sluice to the level of the tail race," then by 62½, and divided by 33,000 foot pounds, gives the theoretical horse-power in the water. Eighty per cent. approximately will be the actual horse power.

A miner's inch is about 150 cubic feet, flowing through an orifice one inch square in one minute, under a head of six inches.

Water will discharge more freely through circular openings, on account of there being less friction.

Water will discharge more quickly from a conical aperture than from any other shaped orifice.

Doubling the diameter of a pipe increases its capacity four fold.

Two hundred and thirty-one cubic inches of water weighs eight and one-third pounds, and measures one gallon.

Approximately, the loss of head in one hundred feet of pipe is equal to .52 the velocity squared, divided by the diameter of the pipe in inches.

To find the horse power at 80 per cent. efficiency, when head and volume are known; multiply the head by the cubic feet, and the product by .00150.

The area of a circle equals one-quarter of the diameter, multiplied by the circumference. The diameter of a circle, multiplied by 3.1416, gives the circumference. Divide the circumference by 3.1416, or 3-1/7, and you have the diameter.

To find the velocity in feet per minute necessary to discharge a given volume of water in a given time, multiply the number of cubic feet of water by 144, and divide the product by the area of the pipe in inches.

To find the horse-power to a certain height, multiply the told weight of the column of water in pounds by the velocity per minute in feet, and divide by 33,000, allowing twenty to twenty-five per cent. for friction, etc.

To find the quantity of water elevated in one minute, running at 100 feet of piston per minute, square the diameter of water cylinder in inches, and multiply by four.

The area of a water piston, multiplied by the pressure of water per square inch, gives the resistance. The area of the steam piston, multiplied by the steam pressure, gives the total amount of pressure exerted.

A turbine is less affected by back water than a water wheel. If there is an abundance of water put in a turbine, it gives the desired speed at once, doing away with all the cumbersome and heavy gear necessary for a water wheel.

The gate of a turbine is generally in one solid piece, is circular in form, and open all the ports at once, letting in the water in equal quantity at each port.

The turbine takes in the water all around. In some patterns it discharges at the center, and in others underneath and above. Those discharging below are preferable, as it requires more energy to discharge above.

A turbine works solely by pressure, so that the more nearly the water above it approaches to being dead, the greater is its efficiency.

The reason why a turbine discharge must work in dead water is that the air being expelled, the falling water causes a pull, or vacuum, thereby giving the wheel a larger percentage of useful effect, and under this action the suction pipe works.

Some engineers claim that they can get about equal power from a turbine using twenty feet of suction pipe, as can be obtained from one placed at the foot of the fall.

Be sure to put the wheel at the foot of the fall, in order to economize power and save annoyance, for it does not appear reasonable that the same amount of power can be obtained by the suction tube.

Be careful to have the shaft from the turbine, bevel gears, and line shaft, put up in such a way that little or no vibration may be felt, thereby saving both trouble and expense.

Chapter XXX.

WIND POWER.

In the last few years wind power has receded into the background so far as its use in driving flour mills is concerned, though there are few complete roller mills driven by wind.

Velocity of wind.—The following table shows the pressure of wind at different velocities:

Description of Wind	Velocity Miles per hour	Velocity Feet per min.	Pressure per Square Foot in Pounds
Hardly observable	1	88	.005 or about 1/12 an oz.
Just perceptible	2	176	.02 " 1/3 " "
" "	3	264	.045 " ¾ " "
Light breeze	4	352	.08 " 1-1/3 " "
Gentle pleasant wind	5	440	.125 " 2 ounces.
Fresh breeze	10	880	.5 " 8 "
Brisk blow	15	1320	1.125 1 lb. 2 "
Strong wind	20	1760	.... 2 bls.
Very strong wind	25	2200	.... 3.125
High wind	30	2640	.... 4.5
" "	35	3080	.... 6.125
Very high wind	40	3520	.... 8.
Gale	50	4400	.... 12.5
Violent gale	60	5280	.... 18.
Hurricane	80	7040	.... 32.
Tornado	100	8800	.... 50.

From the above table it will be seen that with a velocity of four or five miles per hour, the pressure is less than two ounces per square foot of wind surface, and that its effective force depends entirely on the velocity.

Chapter XXXI.

WATER WHEELS.

Water wheels are generally used in three forms, namely: The overshot, the breast, and the undershot, the former being the most efficient considering the amount of water used. For this reason, the overshot wheel is always preferable when the supply of water is limited.

When wheels are simple in construction, erected in a substantial manner, with buckets of the most economical form, their efficiency is almost as high as that of a turbine.

The water wheel is not so good as the turbine in very cold climates, as it will often freeze.

Water wheels work by the weight of the water, and care should be taken to allow only enough water to go onto the wheel to fill the buckets, as more than that is superfluous, and therefore wasted.

The overshot has a little advantage in efficiency over the breast wheel, on account of the water striking the wheel in the direction it is running, but the amount of power developed in this manner is very small.

A water wheel should always run clear of the water in the tail-race, as it is more easily affected by backwater than the turbine.

When the mill is standing for a day or so, it is good policy to look the wheel over to see that everything is in order, and to make repairs on the buckets if necessary.

When water is scarce, a wheel should run without splashing or wasting any water, as every drop counts in dry weather.

Never waste a moment in studying up plans to use the water after it has passed the wheel, as its power is spent until it meets another fall.

The following example will show the method of computing water power:

Multiply the width of the flume or stream which is 10 feet by the mean depth which is 3 feet, and that by the velocity of the stream which is 100 feet per minute, which gives 3,000 feet of water per miuute; now multiply this by a cubic foot of water which is 62½ pounds or 62.50 pounds, and the quotient by the head in feet, which is 20 feet, and the result would be 113.63 theoretical horse power. Deduct about 17% to 20% for actual horse power.

Arithmetically the result is the following:

$$\frac{10 \times 3 \times 100 \times 3000 \times 62.50 \times 20}{33{,}000} = 113.63 \text{ horse power.}$$

Chapter XXXII.

THE TURBINE.

No better or more reliable power can be found for a mill than the turbine, where there is enough water at all times, so that it may be run at full gait if necessary.

The power is always in the control of the miller, and if everything in connection with the gates is properly arranged, it is regular and effective.

In this department of the mill as in every other, too great economy should not be exercised. The flume and penstock must not be too small; indeed, they can not very well be too large. They should not be so small as to cause the water to run and fall at the rate of 300, when it should fall at the rate of about sixty feet per minute. Speed means friction, and friction means loss of pressure, and therefore loss of useful effect.

When constructing a penstock for a wheel, always be careful in laying the bed or foundation, so as to have a good discharge pit.

If of a soft substance, such as sand, clay, earth, or any loose material, mud sills will have to be put in, with sheathing of two-inch planks on the bottom. There is no need to be afraid of having the discharge pit too large. It should be from four to

eight feet deep, four to eight feet wide, or larger according to size of wheel, and should extend out several feet from the penstock, sloping upwards until it touches the level of the tail race.

The free discharge of a turbine is very important, and unless the water passes away from the wheel freely it will react, thereby lowering the percentage of useful effect.

Have the turbine discharging into dead water at all times, and prevent air entering the turbine discharge, or the vacuum will be lost.

When erecting a flume and penstock it is well to calculate the timbers very carefully, and have the corner posts bolted one to the other to prevent spreading, for the pressure is very great, and the expansion and contraction of the timbers by moisture is also very great, and must be guarded against.

In Fig. 52 is illustrated the method of erecting a flume and penstock that gives very good service, is very simple, and when built on the right lines is very durable.

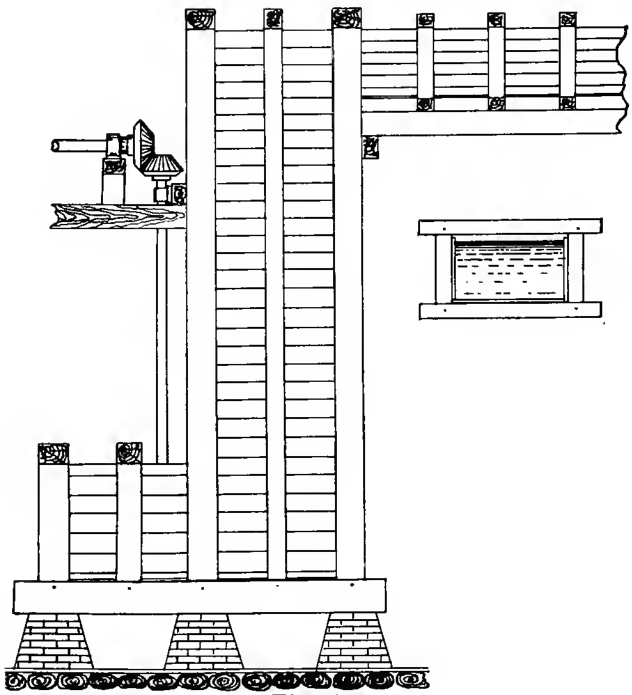


Fig. 52.

Large penstocks should rest on side walls or pillars, and pillars are preferable as they allow free discharge of the water from the turbine.

Frame the floor of a penstock very strongly, cover the floor with 2-inch to 2½-inch soft planking, tongued and grooved, and allow space for the discharge tube of the turbine to pass through, and a perfectly level place for the flange of the wheel to rest.

The turbine tube hole must be large enough to move the wheel slightly to center it correctly.

Right under the turbine, should it be large and heavy, there ought to be placed four 6 x 6-inch uprights to support the center of the floor, or it will sag with the great weight resting thereon.

After planing the floor where the flange rests put tar, and on that three or four layers of soft twine, which will prevent the passage of water as long as the penstock stands.

Sound judgment teaches that for heads of thirty feet or over it is the most economical plan to put in an iron case and penstock.

In some localities lumber and labor are very cheap and iron is very expensive, so that wooden penstocks have to be made for high heads.

Some years ago the writer had to erect a wooden penstock for a head of fifty feet, using 700 feet of water per minute. An 18-inch Alcott wheel was put in. The corner posts of the first thirty feet were 16 x 16 inches. The other twenty feet corner posts were 14 x 14 inches. The discharge pit was cut into natural concrete, and was 4 x 12 feet, and 4 feet deep. The penstock was 4 x 4 feet square inside. As about 700 cubic feet of water was passing per minute, it sank in the penstock at the rate of about 45 feet per minute, and made one of the most reliable powers the writer ever had under his supervision. The head miller has run the mill five weeks without a single shut down, only taking care to keep the rack in the forebay clear of leaves, etc.

It is better to be above than below a certain size in dimensions of a flume and penstock, as better results will then be obtained, and there will be no annoyance.

The construction of the penstock mentioned was similar in appearance to the one given at Fig. 52. After the water had been in it for a few hours it stopped leaking, and has since cost little or nothing for repairs, after 20 years continued service.

The straight penstock has many advocates, but in the opinion of the writer the armed one is preferable, as the bearings are on the outside, and it looks much neater than the straight one. Some claim that there is more power on the turbine by a straight shaft; but they do not take into consideration that the pressure is equal on all parts at the bottom of a penstock. Of course, there would be a difference in favor of a straight penstock if the water was making a mad rush of about 300 feet per minute to get to the wheel, thereby losing a part of its useful effect at the further side of the turbine when in an armed penstock.

Never be opposed to having an arm in the penstock, for if it is large enough to allow water to sink easily, the loss will be so small that it will be overcome by the bearings being outside, away from sand and dirt. They will also last much longer when they are free to be lubricated.

These remarks are all for the setting of vertical wheels. It is so seldom that horizontal wheels are used that all the necessary instructions may be obtained from the makers.

In recent years there have been many more horizontal turbines used than formerly on account of the great development in large water power all over our land, and this type of wheel is preferable on account of the simple connections to the machinery to be driven.

When setting a vertical wheel, place it at equal distances from the side of the penstock, so as to allow the water free entrance; often, for high falls, and where it is difficult to build a penstock, a draft tube is used, placing the wheel twenty or thirty feet above the tail-race. It is best never to allow more than twenty feet of draft tube; set the wheel on the bottom, if possible, as the draft tube is troublesome, and must be kept perfectly air tight, or its efficiency is impaired. When a draft tube is resorted to, let it be conical, the smaller end at the turbine.

The bottom must be in dead water at all times. Always make the deck of a penstock as strong as the shaft. A few bolts at intervals is good economy. In placing large wheels, the draft tube being separate, it is best to place it in position first.

Keep the water running to the wheel as free from debris as possible. Put a rack in the forebay, and if one will not do put in two, for they must not be too fine.

Where the feeding canal runs for miles, and is open, it receives all manner of refuse. In this case it is wise to have three racks, the first with bars about six inches apart, the second three inches apart, and the third three-quarters of an inch apart for small wheels. The bars should be one inch apart for wheels up to forty inches, and one and one-half to two inches apart for large wheels.

Be careful to have the head and tail-race large enough to allow the water perfect freedom to enter and discharge.

It is an easy matter to arrange an automatic rack cleaner, which can be driven by a crude paddle wheel. All that is required is a traveling comb, running at an angle, to drop the debris after reaching the top of the rack. It may also be driven by the mill, when convenient. A good rack can be made of iron or steel bars, half an inch by two inches. Drop them into a half inch board, tapered up stream. Leave the bars clear at the top so as not to impede the rake. Incline the rack to an angle of about forty degrees.

Avoid turns in the forebay whenever possible, especially sharp ones, as it impedes the flow of water to the wheel.

Three feet per second is the speed generally allowed for water to travel to the wheel, but it is better to allow it a speed of one and a half feet per second.

When considering the building of a mill on a stream, the first is to ascertain the head of the fall, and the amount of water passing, and it is the best of policy to engage an engineer for this purpose.

Chapter XXXIII.

BURRS IN MILLS.

The day of usefulness of the burr in a flouring mill has almost passed away. The man who upholds them against rolls is generally considered a little unbalanced mentally.

That their work is inferior to that of rolls is not to be doubted. There is but one place where they are of use in a roller process mill, and that is on pure fine middlings, and there they can do much good work when properly handled.

A burr must be placed upon as solid a foundation as possible, or severe vibration will ensue.

After a burr is dressed and ready to be laid, level the stationary or bedstone, placing the ends of the level over each levelling screw, which are placed triangularly beneath the burr; and when thoroughly level proceed to tram, to find out if your spindle is perfectly plumb, which is very important.

Various forms of tramming sticks and pots are in use, those most commonly employed being of wood and fastened on the head of the spindle.

After the tram is in position, feather fixed and ready, turn the spindle gently, and take notice that it touches all around the skirt of the stone.

The adjusting screws are in the footstep, and if the feather touches on the north side of the burr loosen up the north set screw very little, and tighten the south one, and so on with any of the others.

When the burr is laid, and swinging on the cock head, the faces being about a quarter of an inch clear of each other, walk around it and press it down with a quick motion. The place that is up is light in balance, and requires weighting at that particular box, or the place that is down may be lightened until the stone is equal at all parts, which condition is called the standing balance.

Now as to the runnning balance. In large mills of former days the spindle of each burr had a small pulley, to run until a running balance could be obtained. By some means, or by its own drive, put the burr in motion, free of outer fittings, such as curb or hopper, lower it until it nearly touches, get a piece of cardboard or a thin piece of lath, put on a thin coating of raddle, or any liquid that will mark the running burr, and push it between the stones, taking care to let it rest on the still one, and the coloring being on the upper side will mark the light side of the running burr, as the balance is just the contrary to the standing balance.

Adjusting weights are generally placed on the back of the runner, for raising or lowering as the case requires.

If a foot step heats, lift out the spindle and clean it out well. If it still gives trouble put in a large copper coin and oil with the best oil.

Every iron about a burr requires marking, so that they may always be replaced where they belong.

Burrs have various dresses, namely: 13 threes, 9 fours, 22 twos, 8 sevens, and many others, referring to the quarters or divisions.

A burr, with the work put in to run with the sun when in the northern hemisphere, is the most convenient to dress, as the dresser may lie on his left side when at work. Have the bush just tight enough to allow for expansion of the spindle, and well greased, being careful not to put the spindle out of tram by doing it. It should be adjusted before tramming.

Burrs having two or three furrows to the division do the best, coolest, and most work.

All the furrows should be run out to reach each end, as this keeps it cooler.

Always have the face of a burr tapering from a circle five inches from the rim to the eye, that is, for the runner only, and say one-quarter inch lower at the eye. It will then act as a gradual reducer, instead of mashing at the first stroke.

A burr in this connection will have greater capacity, be cooler, take less power, and its product will be of a better quality.

Keep the furrows sharp, but smooth, to insure good work, and put in about six cracks per inch for corn, eighteen per inch for wheat, and about fourteen per inch for middlings.

Furrows should be curved at the cutting, or feather edge, as they keep sharp longer and do much better work.

The furrows should be wider at the eye than at the skirt, which causes it to crack more gently upon the grain entering, and also gathers better.

Give the furrows draught in inches equal to the diameter of the burr in feet.

When taking up a burr, see that it does not strike the driver too hard, or it may cause trouble in the adjustments. When the burrs are apart, and laid out, clean the faces of each until there is not a speck of dust on the surface, or it will stick to the staff. It is a good plan to beat the face of each with a piece of three or four-inch belting, which will remove the dust from the pores, then sweep well.

Take the staff out of its box, wipe, and lay the raddle, or coloring material, equally on all parts. Then brush it lightly with the ends of the bristles of a soft brush, until the face is just moist. Next, take it in both hands, placing the tips of the fingers in the groove on the staff for that purpose, stand on the center of the burr with feet clean, and with a swing from one side make it circle over the face of the burr. Be careful not to let the staff stand long, and when in motion, see that each end projects an equal distance over the skirt.

The face, inside of five inches of the skirt, must be chipped off as long as the coloring shows on it.

When through with the staff, wipe the working face until perfectly dry, and put it away. Always handle it with the greatest care, as the burr depends upon the staff for its good results.

Staffs are generally made of the finest, close-grained hard wood.

A staff should be proved once a week when in use every day.

A staff-proof and spirit level are combined in one instrument.

When proving a staff rub a very light coating of fine, thin oil on the proof, lay the working face of the staff on the oiled surface and move it. The parts touched with oil require scraping off with a piece of sheet steel, kept sharp at the edge for the purpose.

The furrows on the burr are best when made one-eighth of an inch deep for middlings, about one-fourth of an inch for wheat and small grain, and about five-sixteenth of an inch for corn.

The self-adjusting driver of today makes it much easier to keep a stone in running balance, than when the old solid driver was in use.

Never run a burr without a sweep, which is a small piece of steel fastened on the side of the runner, to carry the stock round to the discharge spout.

Never get a burr so low as to make the stock clammy, or so hot that it will burn

the fingers, as is often done in mills. This will ruin the stock and fill up the furrows, making it necessary to take up the stone, to clean, often having to wash the same.

There is no denying the fact that a burr will do splendid work on pure middlings. But the trouble is in dressing, getting empty, and other inconveniences.

It is very dangerous to run a burr at a high rate of speed, unless the binding hoops are thick, well made, and of sufficient strength to withstand the tremendous centrifugal strain. Bear in mind that a burr is only in so many pieces, and when running every piece is ready to fly according to the force attracting it, and woe to the person standing beside the millstone when it bursts.

When it is remembered that centrifugal force is anything running or extending from the center, a good illustration of this force may be obtained in a simple manner. Take a stone weighing one pound, or thereabouts, fasten it to a string, and take the end of the string and swing it around and around. The force thus developed will give an idea of the strain on burrs, fly wheels, circular saws, and all heavy circular bodies. Keep the back of the runner smooth, and in good condition, which is easily accomplished by the use of plaster paris.

There will always be a place for mill stones in mills and factories making paints, spices, cement, mineral products, etc., that are in daily use and consumption.

Burrs are in constant use in feed milling, and many there are who ask for burr flour, saying that the roller flour is not the equal to the good old stone ground flour.

Many country mills have built up a very flourishing business on burr ground corn meal, buckwheat flour, graham flour, etc.

Many mills are making money by advertising water ground corn meal and buckwheat flour, just as if the power had anything to do with the making of the meal; but then, the people have to be humbugged.

The main drawback to stone milling is the correct dressing of the same, and so few millers of today understand it, that it is difficult to even get them dressed at any price.

The power required to make a barrel of flour, approximately, is ten horse power; or three and a half barrels may be made in twenty-four hours by each horse power.

No definite test that can be relied upon can be made of other machinery in flouring mills, as the variation in feed in different mills renders it impossible to make such a calculation.

The ten horse power per barrel of flour, per hour, in a well regulated mill, includes everything, wheat cleaning, receiving, etc. However, there are mills in which will take as high as sixteen horse power per barrel per hour, as it takes fully one-half of the power to run the complicated and unnecessary machinery. The man in charge may be using several horse power in mashing and pulverizing his stock on the rolls, which is unnecessary. Some mills have more returns in the flow than straight runs, which absorbs much power uselessly.

A man must be constantly on the lookout around his mill to save all the power that he can, as it is a very important factor in the item of profit at the close of the year's business.

Every little thing that will absorb unnecessary power should be carefully watched. Let a bearing be ever so small, if it is without oil it will increase the amount of fuel used.

A four foot burr, running at 150 revolutions per minute, and grinding six to eight bushels per hour, requires seven and a half horse power.

The speed and approximate capacities of upper runner burrs:

20 inch burr	4 to 8 bushels per hour,	700 revolutions	7 horse power
24 inch burr	5 to 10 bushels per hour,	500 revolutions	8 horse power
30 inch burr	7 to 12 bushels per hour,	350 revolutions	9 horse power
36 inch burr	8 to 16 bushels per hour,	300 revolutions	11 horse power
42 inch burr	9 to 20 bushels per hour,	250 revolutions	13 horse power
48 inch burr	12 to 30 bushels per hour,	200 revolutions	16 horse power

There are mill stones of various manufactures and kinds of stone used, namely, french, peak, gray, esopus, sandstone, etc.

There are the vertical, under runner, upper runner type of burrs, all of which are good for any work they have to do when set up and dressed correctly, and when in perfect face and tram, and with sharp furrows they can turn out the work very fast.

CHAPTER XXXIV.

ROLL EXHAUST.

It costs but a little time and a small sum of money to put in exhaust on all the rolls in the mill. The time and money are small items compared with what is saved in spouting, in keeping the mill clean, in preserving the millers' health, etc.

Some manufacturers of rolls make arrangements to have exhaust spouts placed above the rolls. This is preferable, as hot air always rises, and the suction placed above is very effective, and to my idea is the only method that ought to be used.

The exhaust spout must lean towards the trunk and be left loose so that it may be taken down at will. At the foot of the spout it should have a square of beading to drop into and must be perfectly air-tight in all parts to insure effective work.

A band conveyor makes a fine arrangement for an exhaust trunk cleaner, also a screw conveyor is very good when placed at the bottom of the exhaust trunk, and the trunk hoppered at the bottom.

When the exhaust is attached there is an absence of moisture, which keeps the spouting and elevator legging from warping and rotting. It also causes the dust to suck into the rolls instead of blowing from them, which assists in keeping the mill cleaner.

When drawing toward the fan, it is immaterial whether you have a curve leading from the main trunk; but there should be a curve at each turn when blowing or leading from the fan.

Have the suction fan just strong enough to draw light dust from the roll furthest from the fan with ease, or it will be ineffective.

Dust from the roll exhaust is the most difficult to collect of any about a mill, as it is so fine and light that the cyclone is ineffective and requires another spout leading from the outlet above.

The Perfection type of dust collectors are the best of all for this purpose.

The exhaust system could be used to advantage on all machines, especially dust, which would cause a suction instead, consequently the machine with exhaust attachment would be a collector instead of a dust spreader, and would make a healthier mill, a cleaner mill, and a more economical mill.

All elevator legging should have exhaust attachment to make them collectors instead of very dusty spreaders.

The exhausting system requires much attention to keep it in perfect running order, and make it effective at all times, by keeping all the trunks clean in every part, for they soon become clogged, when they are ineffectual for doing the work for which the system was intended.

Always have the exhaust above rather than below its power, so that there is always sufficient power at the command of the operators, for it is very annoying when power is needed and cannot be had at the right time.

Chapter XXXV.

ELEVATORS.

Elevators are an indispensible part of the mill, and certain points must be observed to have them work satisfactorily and economically. If they run too slow, they carry stock down the return leg, because of not having centrifugal force sufficient to throw it clear of the bucket. If they run too fast, they return stock, holding it in the bucket until it has passed the delivery point.

The lighter the stock being delivered, the slower it should travel, and the heavier the material is, the greater will be the speed permitted for safe delivery.

Elevators should never be allowed to return stock. It is a mistake to run all the elevators in a mill off one shaft, at the same speed, and all having pulleys of equal diameter. With such an arrangement some will deliver well while some will not, because the speed is too fast or too slow for a perfect delivery. While the return of stock in elevators is a source of great annoyance, nevertheless there are few modern mills that are free from it, and this emphasizes the necessity of knowing both how an elevator should be constructed and how it should be operated.

To find the number of feet an elevator travels per minute: Multiply the circumference of the head pulley in feet by the number of revolutions of the pulley per minute, and the product is the feet per minute.

The speed of elevators range from 100 to 500 feet per minute.

The larger the diameter of the head pulley the fewer revolutions it ought to make; and the smaller the head pulley the more revolutions it must make to deliver an equal amount of material.

Any miller with a little ingenuity and good judgment can make his own elevator hats and boots, if he is obliged to.

The width inside the head and boot should be about half an inch greater than the belt. For the projection of the bucket, allow an inch play at least.

Flour, as well as fine, soft, and light middlings, or other light stock should be carried at a speed of from 100 to 160 feet per minute. Oats and light grain should have a travel of 150 to 250 feet per minute to deliver well. Wheat, corn, peas, beans or any heavy grain, should have a speed of from 200 to 400 feet per minute. A higher speed is possible, but is not advisable.

Mill elevator pulleys should not be smaller than 20 inches in diameter unless the mill is very small.

Have the driving shaft in perfect alignment, and the head pulley equally divided or the buckets will run against the sides.

Do not tighten the belt too much, and for any mill up to 200 barrels per day, the elevator belts may be tightened sufficiently by hand. Elevators will run where the boot pulley is standing, the weight of the elevator belt and buckets giving enough adhesion to drive it when loaded.

There are many ways of tightening the buckets. A handy method is to have a buckle the width of the belt, and about one and a half inches deep, with two or three tongues. This permits the shortening of the bucket belt in a few minutes.

Another way is to fasten the upper end by two short screws to the back of the leg and pull up by hand or block, and when tight enough have a board just wide enough to go inside the legging. Put it beneath a bucket, press it to the back and rest it on the base of the opening. A block may be made to hold it alone.

Fig. 53 gives an illustration of a good tightener, which is self explaning, cheap, and easily handled.

Fig. 54 shows another efficient tightener which is easily made, and self explanatory, is very cheap, and very expeditious to work with.

Alarms to indicate choked elevators are excellent devices where a miller has to attend to other duties; but if a miller is alert and alive to his work he will quickly know when an elevator is clogged.

The discharge spout of an elevator must be free from ledges and wide as possible.

When an elevator chokes by overfeeding and stops, release it at the bottom; at the up side first, and if it does not start, relieve the other side also. When an elevator chokes that belongs to the flow proper, it is generally traceable to the discharge spout; therefore release it at the head and then at the boot.

When a choke occurs, do not push and bend the buckets. The choke has a cause, and unless that is found and relieved, it is useless to push the buckets. Often impetuous people will push, perspire, and curse, and possibly take a club and break the buckets, when a little common sense, patience and a half a minute's work would have relieved the elevator at the boot and set things right again.

It is very poor policy to have an elevator belt as tight as a violin string, for when it chokes it is a bad choke, the stock is wedged tight, and it is much harder to get loose.

It is much better to have it just tight enough to touch the lower pulley, and it is immaterial whether the lower pulley revolves or not, for the weight of the belt, buckets and stock they carry are sufficient to give the adhesion necessary to good work.

It is always more economical to run the elevator belts a little slack, for it saves power.

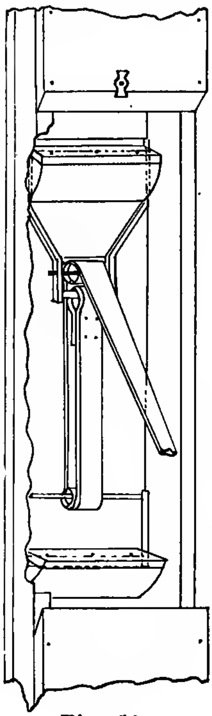


Fig. 53.

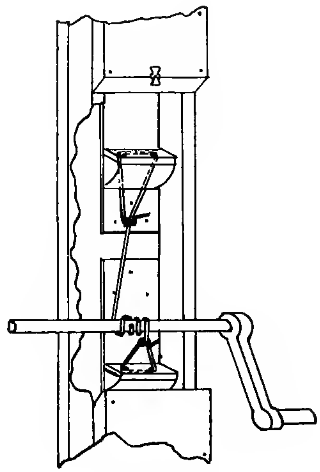


Fig. 54.

SPEED OF ELEVATORS.

Belt Speed	Size of Pulley
150 to 170 feet per minute	10 inch pulley.
160 to 180 feet per minute	12 inch pulley.
170 to 190 feet per minute	14 inch pulley.
180 to 200 feet per minute	16 inch pulley.
190 to 210 feet per minute	18 inch pulley.
200 to 220 feet per minute	20 inch pulley.
220 to 250 feet per minute	24 inch pulley.
300 to 350 feet per minute	36 inch pulley.
400 to 450 feet per minute	48 inch pulley.
500 to 550 feet per minute	60 inch pulley.

THE APPROXIMATE SPEED AND CAPACITY OF ELEVATORS.

Head Pulley	Size of Cups	Revs. of head pulley	Belt speed in feet per minute	Capacity in bushels per hour, cups 16 inches apart
16 x 4	3 x 3½	48	200	70 bushels.
16 x 5	4 x 3½	48	200	95 bushels.
18 x 5	4 x 3½	44	208	130 bushels.
18 x 6½	5½ x 4	44	208	250 bushels.
20 x 5	4 x 4	42	220	180 bushels.
20 x 8½	7 x 4	42	220	325 bushels.
24 x 5	4 x 4	37	232	190 bushels.
24 x 8	7 x 4	37	232	350 bushels.
24 x 10	9 x 5	37	232	670 bushels.
24 x 12	11 x 6	37	232	1000 bushels.
30 x 13	11 x 6	36	283	1400 bushels.
30 x 14	12 x 6	36	283	1600 bushels.
36 x 13	11 x 6	36	283	1650 bushels.
40 x 14	12 x 6	34	356	2050 bushels.
40 x 16	14 x 6	34	356	2300 bushels.
48 x 16	14 x 6	32	402	2600 bushels.
48 x 21	18 x 6	32	402	3400 bushels.
60 x 16	14 x 6	30	470	3000 bushels.
60 x 23	20 x 6	30	470	5200 bushels.

To figure horse power necessary to drive elevators:

Multiply the capacity in pounds per minute by the height of the elevator, and divide by 33,000. Add about 33% for friction.

Example: How many horse power would it require to drive an elexator 50 feet high, discharging 2,000 pounds per minute.

Arithmetically we have the following:

2,000 x 50 = 100,000 ÷ 33,000 = 3.333 horse power; add 33% = 3.434 horse power required.

Chapter XXXVI.

CONVEYORS, CAPACITIES, ETC.

Conveyors are a necessary evil in a mill perhaps, but they should not be tolerated except where their use can not be avoided. They are great abrasers of the ground product, which is the chief objection to their use. Iron and wood are generally rough, and are great consumers of power, although their use to some extent, is almost unavoidable in the average mill; and there are mills that have been planned apparently with a view to carrying the stock as much and as far as possible in the abrading conveyor. The writer has known mills of less than 300 barrels capacity with no fewer than 14 long conveyors.

Several forms of conveyors are used in mills, but they generally pass under the two names of worm and belt conveyors.

Worm conveyors are right or left handed. A left hand worm conveying from you, has the stock on the left of it; a right hand conveyor has the stock on the right.

Steel, iron, tin, zinc and wood have all been employed in the construction of conveyors.

The gas pipe conveyor, as its name indicates is made of gas pipe with iron flights that pass clear through and fasten on the other side. It is reversible, durable, and gives but little trouble.

The continuous conveyors are good when smooth, but are liable to strip if they become choked and the drive is strong enough to do it.

Wooden conveyors are easily made and are reversible, but they are troublesome at times, as the flights work out of the shaft, or warp and break as the wood is affected by moisture and temperature.

There is an anti-friction conveyor, but its only use is in a dead air chamber or dust collector. It is a continuous coil and will work if the box is full of stock, as the centre is free except for the shaft.

TABLE OF CONVEYOR CAPACITIES.

Outside diameter in inches	Approximate capacity per hour in bushels	Revolutions per minute
3	90	100
4	140	100
5	280	125
6	380	140
7	580	140
8	780	150
9	980	150
10	1380	180
12	1950	180
14	2400	200
16	2900	225
18	5900	250

A long conveyor on wheat is a good scourer and all the harm it does is the consumption of power and therefore cost of fuel.

A good safety guard on a conveyor that chokes is to leave a foot of the lid loose beside the discharge spout.

Do not try to start a conveyor without first relieving the discharge spout. Many neglect this obvious precaution.

The most economical conveyor is that of the belt type on account of the small amount of resistance, and the silent manner in which it performs its work.

A belt 30 inches in width will convey 10,000 bushels of grain per hour at a very small outlay for power.

A tripper is used on the band or belt conveyor which is placed on rails, and which will trip the grain into any bin desired, and at any part of the track.

The band conveyor has replaced almost every other grain carrier of late years in mills and elevators, and it would be almost impossible to run the large elevators without them today on account of the large amounts of grain handled.

The pneumatic system has been superseded by the band conveyor on account of the great saving of power and cost of installation.

The approximate speed for grain belts is 425 to 575 per minute, and the maximum speed for belt conveyors is 775 feet per minute.

CAPACITY AT 100 FEET PER MINUTE.

Pulley diameter	Belt width	Capacity in bushels per hour
18 x 12	10	120
18 x 14	12	155
20 x 16	14	220
20 x 18	16	265
22 x 20	18	340
22 x 22	20	425
24 x 26	24	610
24 x 30	28	825
24 x 34	32	1120

Horse power necessary to drive conveyors.

Multiply the capacity in pounds per miuute by the length in feet, and divide the product by 99,000; add about 30% for friction.

How many horse power would it require to drive a conveyor 50 feet in length, conveying 2,000 pounds per minute.

Arithmetically we have the following:

$$\frac{2{,}000 \times 50}{99{,}000} = 1.111$$ horse power, with 30% added making 1.48 horse power approximately.

Spiral conveyors carrying any kind of grain or rough material ought to be lined with zinc or sheet metal, or it will wear out the side and bottom of the conveyor very quickly.

Chapter XXXVII.

PACKING AND PACKERS.

The packing of mill products has been brought down to almost a science, and the machines that are manufactured to pack flour, cereals and feeds in all sizes of packages is really marvelous.

In the old world their packing of flour is almost all done on the crank packer on account of the very large sacks used for flour, and it is a very handy packer at that.

In the present age in the old world, and in fact all parts of the world they are using the auger packers as invented by the Americans, and which are certainly a great improvement over the crude methods employed formerly.

In South America some 20 years ago, and suppose it is the same today in many countries, almost 50% of all the flour produced was packed by hand, foot or knee by the peones, who would strip off to small cotton hip pants.

Sacks when packed ought to be very neatly tied or sewed, for they look very bad unless neatly fastened.

The large mills generally pack for export trade in 98s, 140s and 280-lb. sacks.

For the home trade flour is packed in the following packages: 2-3-5-6-10-12½-20-24-24½-48-lbs. paper sacks; 5-10-12½-20-24-24½-48-98-lb. cotton sacks; 98-140-280-lb. jute or gunny sacks and barrels, ½ barrels and ¼ barrels.

It is too bad that we can not dispense with the 196-lb. barrel and pack every thing by the 100 pounds; making the packages 5-10-15-25-50-100 pounds, for how simple it would make calculations, how simple the packing, and what a saving in outlay for sacks on hand; and where we have thousands of each one we would have hundreds.

Let every man work for the metric system in all our flour and grain weights, for it will benefit all.

The mill builders show the packers in their respective catalogs so plainly, and give so many particulars regarding their merit, that it is a waste of time and space to give the details here.

To examine the packers in the catalogs it is well to take a powerful reading glass to see the parts more plainly.

For hand packing, a plain spout, vertical, with a hook in front, and a half inch strip of wood nailed around the spout may be used in conjunction with a slide of iron an eighth of an inch thick .

A very good hand packer may be made from a conveyor. It has a crank handle and blades on the shaft just above the spout. Between the blades and spout a slide is used.

If it is necessary to run the auger packer when the mill is shut down a very good arrangement may be made by the use of a chain and sprocket wheel. Have a good sized sprocket put on the packer shaft, and have about ten feet of chain ready. When

flour is required, remove the driving belt, place the chain on the sprocket, fasten it and it is ready to turn by hand. The chain simply hangs down so as to be easily reached and worked. This is for loose packing or grist work.

If the packer driving pulley is on the end of the shaft, a crank may be easily put on to turn the packer by hand.

Men become very expert in packing all kinds of products in all kinds of packages, and it is easily understood when a man is an experienced packer. It is marvelous how an experienced packer will pack and nail flour barrels. In tying sacks there is a miller's knot that is very handy, and a swift tie, and all packers should understand it.

It is a great sight to enter the packing room of a large flouring mill and see the army of packers of all ages, the sewers of the sacks being boys and girls.

The boys and girls are being replaced by the automatic sewing machines for the sacks, which do them so much faster, and more economically.

CHAPTER XXXVIII.

LUBRICATION.

Bearings of all kinds must be oiled according to the varying conditions under which the machinery is working. The loads may be light, medium, or heavy; and the machinery may be running with variations of speed from very slow to very fast. All these conditions may, and generally do exist in the same mill in its various working parts; and they must be considered by the oiler if his work is correctly and economically done. Watchfulness and good judgment are requisite; and with these qualifications a good oiler in a large mill would easily earn the extra pay that he might get through the saving in oil; in the rebabbiting of the boxes, in saving fuel, and in the prevention of fires and accidents. The sum total of the results of good oiling as compared with the haphazard, careless method would amount to a great deal in the course of a year.

Bearings at rest are liable to have all the oil pressed out from the under side; and if the oil is thin in nature, it will leave the bearing almost dry before twelve hours have elapsed, consequently it requires a good deal of power to start a lot of machinery.

A miller should always make his mill as light as possible in starting by having his cleaners empty or off altogether, and the pressure off all the rolls.

The best kinds of grease should be used in a box to catch a hot bearing, but one should not expect the bearing to be lubricated in this way, for in a short time after the grease is put there, it becomes separated from the shaft, causing it to heat, and must do so to enforce lubrication by melting the grease.

A box to use grease and which may be made to do good service must have straight sides and ends, causing less friction, and the lid being cast metal and rather heavy, acts as a pressure valve by resting on the grease.

Bearings having much pressure and not running over 100 revolutions per minute require oil that has a good body. Castor oil is excellent and must be used sparingly, or it becomes very expensive.

Roller bearings cause much annoyance by heating, and the obvious remedy for the trouble is to allow more bearing surface; the box in length should be four times the diameter of the shaft. Another remedy would be to put on self-oiling bearings, causing a constant flow of oil through the box.

One great cause of overheated bearings on rolls is the over-crowding of them, requiring the belts to be kept very tight.

Oil for roller bearings should be of the best quality possible, not too thick, but of a lasting and easily circulating nature.

A bearing must have a thin film or fine sheet of oil between it and the shaft to insure good and economical work, for let any two points of the metal come together and there will be heat, wearing of parts, and waste of power.

To insure good results by hand oiling, the work must be done systematically. But even at its best, in a large establishment hand oiling is expensive and wastes enough power to pay for the best improved automatic bearings. Of course, automatic journals require looking after to see that they contain a constant supply of lubricating material.

Bearing and shaft must be separated by oil and must be equally smooth. The shaft must be perfectly round and straight, touching all parts equally. The box must be perfectly round in concave and in equal touch with the shaft.

Always have enough play to allow for expansion, for often the shaft will expand at a greater ratio than a journal and commence smoking from this cause.

Do not pour cold water on a smoking hot box. It is liable to crack it, and besides, it will do the shaft no good.

Graphite or black lead mixed with oil is good to put into a hot or cutting box. Powdered brimstone is also excellent.

The ordinary causes of hot boxes are as follows: belts and boxes being too tight; shaft or boxes out of line; absence of oil; having more than 300 pounds pressure per square inch on boxes; shaft and boxes out of level. If the heating is constant, it is evidence that the box has not surface enough for the load it is carrying.

End play in a bearing is desirable, and the shaft should be perfectly free from spring and the boxes firmly set.

If a bearing becomes very troublesome water may be poured from an oil can into the bearing very slowly at the oil inlet onto the shaft, in this way it will wash out the bearing, and by going to the shaft first it will contract it, and will relieve the pressure; pour on the water at intervals, then a little oil until the bearing cools.

With high speed shafting use the best machine oil, not thick, but of a lasting nature, as the bearing must not be allowed to remain a second without oil.

A glass lubricater with pin is good for light and fast running shafts, as it gives a small and continuous supply, which is really the only correct way of lubricating shafting of this description.

The cap of a journal should always rest on the shaft, but must not be screwed down tight. By resting on the shaft it assists lubrication. The writer took charge of a mill not many years ago where considerable trouble and expense had been caused by the roller bearings heating. The pressure was not excessive, and the cause of the heating had been something of a mystery. After operating the mill for a day, he noted the particular offenders, removed the caps, cleaned them out, made the packing just thick enough to allow the caps to touch the shaft, put in fresh grease, applied a little oil in each before starting up, and lo! the trouble ceased entirely. The difficulty had been mainly caused by the miller's relying entirely on axle grease for lubricating. It will not act, and a resort to it simply courts annoyance and expense. Grease is all right on some bearings when under pressure, and kept in constant contact with the revolving shaft.

A word about the oiler. Aside from the importance of his work, he has every opportunity of becoming entirely familiar with every part of every machine in the mill. If he intends to become a miller he can lay the foundation by a minute knowledge of every machine and every part of it, if he will use his eyes and reflective faculties. And this will not retard or interfere with his work as oiler; but the more he studies the machinery in his charge, the more intellingently he will do his work. When he once learns this fact, he is in the line of promotion from his tiresome but necessary function as oiler.

Oiling, the same as sweeping, appears very very simple, but how few men around a mill can do either correctly, and it requires the best judgment and care to do either of them as they ought to be done.

It is the same with oiling as it is with every thing else, "If it is worth doing at all it is worth doing well," and the apprentice that starts out with that constantly in his mind will eventually become a competent miller.

When a journal becomes heated it is certain there is a cause, and it ought to be remedied as quickly as possible, for if ye seek ye will find.

CHAPTER XXXIX.

SPOUTS AND EXHAUSTING.

If it is desired to blow two fans into one trunk, do it as shown in Fig. 55 and always make the spout larger at the inlet of the second fan.

It is not policy, however, to blow two fans into one trunk, as there is always more or less back pressure when a dust room or collector is used.

When making a turn in a trunk make it circular, so as to cause no impediment to the flow of air in its passage to the dust room or other parts.

All spouts that convey wheat, or first, second and third break stock, should be made of either zinc, sheet iron, or wood lined with sheet iron, as they last but a short time when made entirely of wood or metal. Always commence at the bottom to lay in the strips of tin.

A sheet of tin will generally make about three strips, if properly cut, and by being round it eliminates a large amount of friction.

Have the tin as round as possible. It is a good plan to press it over a roller about four inches in diameter.

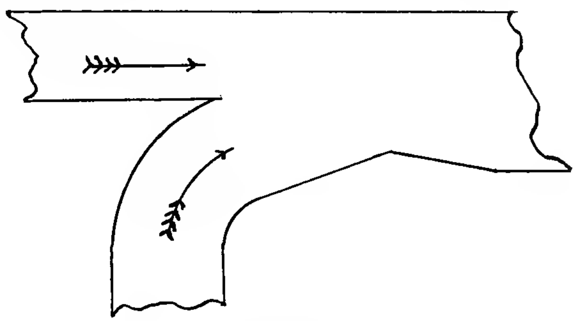


Fig. 55.

Six tacks in each strip of tin is sufficient.

When lining a spout with sheet iron or zinc for wheat or other rough material, it must be put in to fit the bottom and sides, and a strip then put on the lid.

Many prefer diamond spouting, but the writer thinks it unnecessary, and very unsightly.

Stock will travel better when lined with tin than any other spout made with the exception of a tin spout.

The degrees of a spout may be discovered by measurement also, but when once familiar with the inches, judgment is all that is required in this respect.

PUTTING UP SPOUTING.

When it becomes necessary for a miller to make and put up a spout he should be able to do it neatly. The spout should be of the right proportions, but not 8 x 8, or something larger, unless it is for an exhaust trunk.

Fig. 56 represents three forms of spouts that are easily made. Each style depends upon the amount and variety of tools at the miller's command.

For mills up to 200 barrels capacity spouts may be made from 2½ x 4 to 3½ x 6 inside. The space in many mills is taken up by large, unsightly spouts, some of which appear, at first sight, to be dry goods boxes with the ends knocked out.

Exhaust trunks are generally square, and must always be as large as the outlet from the fan. A little larger, even, will not be out of place.

Always use the bevel when putting up spouting, for guess work is very costly, and proves very unsightly by misfit spouting.

Have spouts to fit snugly in every part, for a little perseverance will get a close fitting joint, and close fitting spouting will pay for themselves many times over in the course of a year by the saving of product, and keeping the dust from spreading over the machinery.

It is good policy to insert glass at the bottom of a spout so that the feed may be seen at all times; but be sure to place it where the stock will pass over it, or it becomes pasted or covered with dust, rendering it ineffectual.

Every spout must be put up with the greatest of care in order that it will not choke at the least overflow of stock; and the greatest care is necessary where each hole passes the floor, for if the smallest ledge is left there, it is a very serious impediment to the free flowing of the stock.

It is the best of policy to leave about 18 inches of the lid loose near the floor, and fastened down by a button so it may be removed in case of a choke, when it can be relieved immediately, for it is almost always near the floor where the chokes occur.

There ought to be a round hand hole in the lid of each spout about three feet from the floor in order to look at the stock whenever passing the spout. The hole should be 4½ inches in diameter, and covered with a lid the shape of a fan when open, and with a screw at the V end of the same, so that it may be pushed on one side at will.

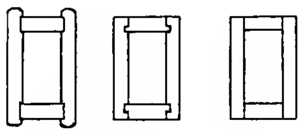


Fig. 56.

Many millers put on loose lids, but it is very bad policy, for they soon get misplaced, and they are used to pound the spouting, and get battered to pieces, and also batter the spouting.

Spouting ought to be well made, and screwed down, and not nailed; and when up, they should have a coat of elastic varnish, which makes them look so neat and clean, and easily kept so.

The mill furnishing houses sell a paper namely, Spout Paper, for lining spouts which is very good and cheaper than tin, but it is easily ruined if the operator is not very careful.

When making spouting it is necessary to have well seasoned lumber, or the spouts when put up will warp and twist, and dust will come out at all points.

I have seen mills where every spout therein was pasted on all sides with patches to keep in the dust, when the holes could have been corked, or stuffed with cotton or other material that could not be seen.

Do not paste every hole in the spouting with patches, for there is nothing so unsightly, and especially at the hedges, for it is easy to cork such holes.

It is very poor policy to batter a spout with all manner of things, making them very unsightly, when they ought not to be battered with anything but a rubber ended mallet, or a large piece of rubber placed on the end of a broom handle.

Spouting with the lid and bottom edges rounded off are the neatest when made.

If a spout gives constant trouble by choking it ought to be remedied at all cost, or it becomes very costly indeed by the waste of time and material, and prevents the uniformity of mill products.

If spouts prove troublesome by not having sufficient fall, it is the best of policy to have almost the entire lid loose so it may be removed instantly. Narrow strips may be inserted underneath the lid just so that the strips fit near the inside of each side of the spout, when it will be dustless, and will not need to be fastened.

Chapter XL.

MAKING CHANGES.

The proprietor of the mill has more than a passing interest in the changes made or proposed in his mill. They mean ordinarily an outlay of money, and he is not to be blamed for being somewhat skeptical as to their necessity or importance. He is certainly justified in going into such matters very deliberately if he has had the experience that some mill owners have with the experimental changes made by their millers. Certainly no miller has ground for offense if the proprietor be slow to allow changes to be made, especially if the miller has just taken charge, or is an entire stranger.

Under such circumstances the miller should be very sure the change contemplated is advantageous. If you have just taken charge, make the round of the mill, and examine the stock in every spout. Master every detail of the mill's work before deciding whether any changes should be made, and how they should be made. Always have a flow, and if one is not at hand, make one. It is a safeguard for a new miller, especially if he sees that a change must be made.

If a change is necessary, make it as simple and effective as possible. Never make a curve when a straight line will do as well, or rather better; and never put in a conveyor when a spout will carry the stock.

A change should never be made as the result of mere guesswork, for such meddling is expensive, and sometimes runious to the mill owner.

There is only about 84 per cent. of flour in a grain of wheat, and it is only folly to try to get 90 per cent. out of it. When the mill is making good flour and a good clean-up, and every one is satisfied with the products, let the miller follow the maxim of letting well enough alone unless he is positive that the proposed change would be advantageous.

But if, after an examination of the stock and flour a change is decided upon, proceed to the work in an orderly manner. After understanding thoroughly what you intend to do, put it on paper. Study it in relation to the rest of the mill and the rest of the flow. Sometimes when a proposed change is half made it is found that it can not be completed, simply because the matter had not been studied out by the miller in advance.

Doing work over a second time is expensive and annoying; and the only way to obviate it is to have it planned and executed in mind and on paper before the actual work is commenced.

If anything is to be ordered from the mill furnisher for a proposed change, it should be written out and carefully noted and compared before sending. Orders should always be copied, so that if a mistake occurs, the responsibility can at once be located.

When making changes, have the new spouting resemble the old, and make the mill look as neat as possible. Too often the work of making changes is done in a bungling way that makes the mill unsightly in the extreme. Millers in charge of country mills are usually quite expert in making and putting up spouting. If they chance not to be, it is better to get a first-class carpenter who, if he has not had experience, must be a very good workman in order to do a neat and expeditious job. A high-priced man, who understands the work is really cheaper in the end, than one working for half the wages, who either is compelled to work very slowly because of the lack of acquaintance with the work, and possibly, even with all his painstaking care is unable to do a satisfactory piece of work.

The writer when constructing mills, elevators, etc., has had carpenters at $1.50 per day, and others who received $4.00 daily, and the work of the latter was more satisfactory all around than that of the former.

The work of the $4.00 workman was more economical for the reason that he

could turn out three times the work of the cheaper man, and when the work was done, it was satisfactory.

Changes are costly, and when the writer was in charge of six mills as superintendent, and was responsible for every mill built, and every change made, he always studied the change out and placed it on paper to a scale before commencing, and never to my recollection had the work to be done over again.

Always be sure and then go ahead is a grand old maxim to proceed by, and it is the best of policy to go slow in changes, and especially where it involves the closing down of the mill.

When making changes, have the work to match the other workmanship as nearly as possible, so as to keep the mill looking neat, for neatness is very much to be desired.

Every miller should have a set of testing sieves to examine the different stocks before making changes, in order to determine the cloth to use, and they will save much time and expense.

Chapter XLI.

BOLTING CLOTH.

Bolting cloth is generally woven 40 inches in width, and in three or more grades: Standard, extra heavy, double extra heavy and triple extra heavy.

When silk bolting cloth is numbered it is generally done in the following manner: 22-X, 22-XX or 22-XXX, or which ever number desired.

Bolting cloth may be relied upon at all times as it is sold under a guarantee by all manufacturers, and seldom it occurs that it does not wear well under favorable conditions.

There are today many prominent manufacturers of bolting cloth of the silk variety, such as Dufour, Bodmer, Schindler, etc.

Historians speak of the bolting of flour some years before the Christian era. Pliny tells us that the Gauls made their sieves of horse hair, and the Spaniards theirs of linen.

The hand sieve employed at the time of Pliny was in use many hundred years, and was clothed with horse hair, linen or woolen cloth.

The first mechanical bolt was invented by a German, about the early part of the sixteenth century, and bolting cloth came into prominence about this time. The cloth was principally made of German and English wool.

England became prominent about this time in the manufacture of woolen bolting cloth, and wire cloth was being used in English and American mills.

The great trouble with wire bolting cloth was its tendency to oxidization.

The manufacture of silk bolting cloth commenced about the year 1780, and was made by the Dutch. In 1832 a Swiss, named Henry Bodmer, began the manufacture of it. He was very successful, and his cloth became a renowned brand.

Not long after this the old reliable firm of Dufour & Co., began to make silk bolting cloth. The quality of this brand is known to every one working in a mill today. Up to this time the Dutch and other manufacturers had only been able to make as fine as No. 8; but competition in the various works soon raised it to No. 16. There is no country in which bolting cloth is made of an equal grade to that manufactured in Switzerland. Around Zurich there must be upward of 2,300 looms at work in its manufacture. It is a case similar to that of yeast making. There is something in the water. England has tried many times to make yeast equal to that of Holland, but failed.

Bolting cloth is woven in various ways. In the best weaves the loop and chain threads entwine their cross threads and hold them in place, so that it is almost impossible to vary the mesh by being displaced. The fineness of the thread in different bolting cloth varies greatly, and the number of threads running one way is considerably more than those running in the opposite direction. The fineness of cloth reaches 210 meshes to the linear inch.

The following table gives the number of the cloth, with the corresponding number of meshes to the linear and square inches. When clothing a reel the cloth requires tightening gradually, and at intervals, or it will be unevenly stretched, which will cause it to give way in places:

No. of Cloth	Squares to Linear Inch	Squares per Square Inch
0000	20	400
000	24	576
00	32	1,024
0	42	1,764
1	52	2,704
2	60	3,600
3	64	4,096
4	69	4,624
5	72	5,781
6	80	6,400
7	88	7,744
8	92	8,464
9	100	10,000
10	110	12,100
11	120	14,400
12	130	16,900
13	140	19,600
14	150	22,500
15	160	25,600
16	170	27,800

The ensuing table gives the relative bolting value of wire and gritz gauze with silk cloth. There is a difference in the number of meshes in the cloth of different manufacturers. The old number is preferable, being fixed in the remembrance; the new will pass out of the mind of a person who is not in touch with them every few days:

COMPARATIVE BOLTING VALUE.

Silk No.	Mesh	Gritz Gauze		Wire
0000	18	16		16
000	24	20		18
00	32	26		26
0	40	34		30
1	50	44		36
2	54	50		45
3	58	54		50
4	60	58		56
5	68	60		58
6	80	64		60
7	86	70		64
8	98	....		70
9	112	....		80
10	116	....	Brass Wire	100
11	124	....		110
12	132	....		120
13	136	....		125
14	144	....		130
15	156	....		150

Gritz Gauze or G. G. numbers are the following: 14-16-18-20-22-24-26-28-30-32 34-36-38-40-42-44-46-48-50-52-54-56-58-60-62-64-66-68-70.

Gritz Gauze is more economical than silk cloth counting first cost.

STEEL TEMPERED BRAN DUSTER CLOTH.

Number of Meshes per Inch	Size of Wire
30	30
35	32
40	33
45	34
50	35
55	36
60	36
64	37
70	38
74	39
80	40

There are many different widths of this cloth.

The next table gives the old and new numbers, and meshes per inch, of a popular brand of sik bolting cloth, the old number I prefer for the reason that it is easily remembered by being carried in the memory.

Old No.	New No.	Meshes per Inch
0000	18	18
000	22	24
)0	28	30
0	38	40
1	48	50
2	52	56
3	56	60
4	60	64
5	64	68
6	72	76
7	80	84
8	84	88
9	94	100
10	106	112
11	114	120
12	124	126
13	130	132
14	140	140
15	150	150
16	150	160
17	160	168

PLATED SCREEN CLOTH.

Number of Meshes per Inch	Size of Wire	Meshes per Inch	Size of Wire
2 x 2	17	20 x 20	30
3 x 3	19	22 x 22	31
4 x 4	20	24 x 24	32
5 x 5	21	26 x 26	33
6 x 6	22	28 x 28	34
8 x 8	23	30 x 30	35
9 x 9	24	32 x 32	36
10 x 10	25	34 x 34	36
12 x 12	26	36 x 36	36
14 x 14	27	40 x 40	36
16 x 16	28	45 x 45	36
18 x 18	29	50 x 50	36

This wire is coated with tin which prevents rust, and having a polished finish, which prevents the tendency to fill up the meshes.

There are two important factors in bolting, quantity and quality, and we have always relied upon silk bolting cloth for giving us the best results, but there has appeared another that claims suppremacy over all bolting cloth, and is multi-metal bolting cloth.

It is claimed to be superior in quality and quantity, is not affected by the weather the same as silk; consequently the bolting is more uniform.

It is a pliable, silky metal gauze, to the touch it is as smooth as silk, and will out wear silk many times, will not crystalize, oxidize, or be affected by heat, moisture or bugs.

It is made from a very strong wire, and by the tensile strength, and pliability, there is less liability to break or tear, causing shutdowns.

I give below the comparative numbers with silk and G. G.:

	Silk				Grits Gauze	
Multi-Metal	Standard	X	XX	XXX	Standard	XXX
18	0000	....	....	....	18	16
25	000	....	....	....	24	22
35	00	....	....	....	30	28
45	0	....	....	....	38	34
55	1	....	....	....	48	44
65	2	....	....	....	54	50
70	3	....	....	....	60	56
75	4	..	4	....	62	58
80	5	....	5	....	66	62
90	6	6	6	....	68	64
100	7	7	7	....	70	66
110	8	8	....	....	72	68
120	8	9	8	8	....	70
130	10	10	9	9	....	....
140	....	....	10	10	....	....
150	11	11	....	....	....	....
160	12	12	11	11	....	....
170	13	13	12	....	....	....
180	....	....	13	12	....	....
190	14	14	....	13	....	....
200	15	15	14	....	....	....
210	16	16	15	....	....	....
220	17	16	16	14	....	....
230	18	....	....	15	....	....
240	19	....	....	16	....	....
250	20	....	....	17	....	....
260	21	....	....	18	....	....

The bolting cloth is 40 inches wide, is sold by the yard, which contains 10 square feet.

There is nothing more useful to an operative miller than a bolting cloth glass to count the meshes of all kinds of bolting cloth. A handsome glass is made that will fold together, and can be carried in any pocket without inconvenience.

It often happens that there is no number on a cloth, and with the glass it is obtainable immediately.

I have in my possession part of a bolting cloth glass that belonged to my great great grandfather, and has been handed down to me, and I prize it very much, and Fig. 57 illustrates that glass.

It is made of brass, the lower plate has the ½-inch, ¼-inch, ⅛-inch and the

1/16-inch holes, and the glass as will be noticed is made to revolve over those holes in order to count the meshes.

Testing sieves are so useful to the operative miller. They consist of two well-made tin rings, with bolting cloth to fit from 0000 to 16.

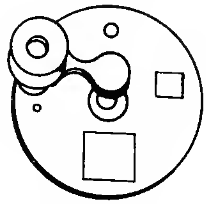


Fig. 57.

To find the amount of cloth required for the different machines it is best to confer with the mill builders who manufacture those machines, or should you be in a hurry you could take the measurements from the machine, being very careful to be exact, or time and loss will be the result.

There is another bolting cloth made of metal that is giving good results they claim and is named Adamesh, and it is claimed to be the only hygenic metal bolting cloth made; and increases the capacity, and decreases the wear of the cloth.

Chapter XLII.

DUST COLLECTORS.

The satisfactory collection of dust in flour mills is one of the most important matters that the milling trade have to contend with, for it means so much to the health of the operators, which is really the important feature.

Every machine in the mill should have an exhaust attached to inhale the dust, and which would add greatly to the health of the millers.

There are some very good dust collectors on the market today that catch the dust and force it out in a solid mass, yet there are none that are perfect in preventing the escape of the very fine dust through the flannel.

The backdraft is the wrost thing to contend with in the collecting of the dust, and if all dust collectors were enclosed in a room to themselves, with an outlet for the escape of the air, it would be beneficial to the health of the operatives, and keeping the mill cleaner.

There must be an outlet for the escape of air, and in the perfection type it has to escape through the flannel, and in that way there is bound to be dust escape with that air, filling the atmosphere with a very fine dust, and that air is breathed by the millers.

In tubular type of machine the air-laden dust enters at the center of the machine and passes to the flannel tubes which collect the dust, which is collected and then discharged while the row of tubes are directly on the top of the machine, and while at that position the air is shut off automatically, and at the same time the tubes are knocked or shaken automatically, when the dust drops to a conveyor, where it is discharged at the side in a solid chunk, which prevents the escape of air at that place.

There are operative millers who think that these machines are so perfect in their functions that they do not need to be taken care of, but what nonsense, for every time the mill is down the tubes ought to be shaken and dusted down with a brush, and tapped with a light switch, which will relieve it of the greasy, fast adhering dust.

These machines require the closest attention in order to do the perfect work desired of them.

The Wolf-Draver Cyclone Tubular Dust Collector has the tubes tapered the same as the other tubular type, yet it works differently by receiving the dust-laden air

at the large end, and the tubes are cleaned while the large end is down at the bottom, which again is the opposite to the regular tubular collector.

There is one good feature in cleaning the tubes at the large end, and that is the dust drops clear, and does not slide down the cloth, which really stops it up, yet the writer will never go back on the Perfection as it is a splendid and very effective collector.

While almost all of these machines receive the air in the center, this machine receives the air at the side.

The tubes are cleaned one row at each revolution of the machine and while that row is at the bottom, and while passing over the dead air chamber.

The coarse dust is caught in the settling chamber as it enters the machine, and only the very fine dust and air enter the tubes.

This same machine is well adapted to the collection of coarse dust from alfalfa milling.

There are also the Wilson, and the Excelsior type of dust collector, which stand on the floor or platforms, and which are made on the square order, with their tubes perpendicular.

The tubes are the same thickness from end to end, and are cleaned partly while in motion with a sliding ring running up and down, but is not very effective, and it is well to give the tubes plenty of cleaning by hand whenever possible.

The dust drops to conveyors and wormed to one side, to another conveyor which takes it to a discharge spout.

We now come to the old stand-by for almost all manner of dust collecting, and all other rough trash such as sawdust, shavings, ore dust, etc., of every description.

In Fig. 58 is illustrated the Cyclone Dust Collector, a cut of which is taken from the catalog of the well-known mill-furnishing house of Barnard & Leas Manufacturing Company, of Moline, Ill., and which describes the exact workings of the same, showing the motion of the air upon its entering, and the motion it takes in its descent until it reaches almost to the bottom, when it rushes up and through the outlet at the top.

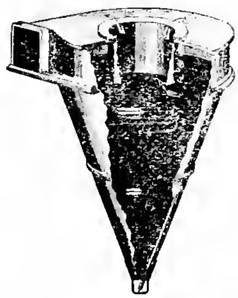


Fig. 58.

The air enters the machine at the side, giving to it a circular or centrifugal motion, and while it is circling around and reaching the bottom it is receiving its tendency to go upward, which it is forced to do on account of the cyclone shape of the machine.

While the air is coursing around the machine, the dust is clinging to the sides and gradually getting to the opening at the bottom of the cone, when it makes its escape to the spout below.

This machine is to be preferred for the collection of coarse material, but not for fine dust.

This machine is manufactured by the well known firm of The Knickerbocker Co. of Jackson, Mich., where they make all sizes and shapes of machines.

Do not be afraid to have too many dust collectors in the mills, for they are one of the best investments to be made, and when they are installed it is up to the operatives to see that they are kept doing the work for which they were intended, for that work is absolutely necessary.

Chapter XLIII.

SCALES AND WEIGHING PRODUCTS.

There is really nothing of more importance in any kind of business than that of weights and measures, for therein lies success or ruin.

The best are the cheapest even if they are the most as a first cost, for in the end they have saved themselves many times by their accuracy in weighing.

There never was an age that was so full of the most perfect weighing machines as there are today, and almost without exception are all good scales, and when bought upon a guarantee, there is no trouble afterwards but what the manufacturer will make right.

Whenever the opportunity presents itself to look over a scale to see that it is in balance it should be done, for they are too often neglected to the detriment of the company or firm.

Have the scales in perfect balance; do not give or take; weigh in place where there is no draft, for wind blowing onto a scale will cause it to weigh incorrectly; also dampness will cause defective weighing.

There are so many different scales that I am not going to illustrate any of them, for it is so easy for millers to get catalogs giving full accounts of the same.

Weighing packers are going to be the scale of the future, and there is a possibility of them being made so perfect that they will pack and weigh a package accurately.

Chapter XLIV.

CORN MILLING.

It was not my intention to write anything upon corn milling, but of late I have had so many inquiries regarding this subject that I decided to give only the rudiments of corn and feed milling, in order to help some of the country brethren who do not know anything about it.

In Fig. 59 is illustrated a flow of a corn mill that can be made to produce from 20 to 100 bushels of meal per hour; or 30 to 130 bushels of feed per hour by adding to the size of the rolls and other machinery accordingly.

The rolls in this flow are 6 x 15, and would have a capacity of 20 bushels of meal, or 35 bushels of feed per hour; and would make on cracked corn about 40 bushels per hour.

This flow is especially diagramed to produce pearl and granulated meal of the finest kind by careful milling, and will make a very close finish.

The first break has 10 corrugations, and could have 10 on fast, and 12 on slow if desired; differential 2½ to 1; spiral same as all 1-inch per foot; fast rolls 600 to 700 revolutions according to how it is desired to crowd the capacity. Break about one-half or 50% on this roll when you desire to take off cracked corn, and about three-fifths when making meal.

The second break has 14 corrugations, cuts, flutes or grooves; differential 2½ to 1; fast roll same as first break; break about three-fourths or until the chop appears half meal, sharp and granular, but not mushy.

The third break has 18 corrugations per inch; differential 3 to 1; fast roll 700 revolutions per minute, break about three-fourths, or until the chop is about three-fifths meal, sharp and granular.

Last or tailings roll has 22 corrugations; differential same as the preceding; speed of fast roll 700 to 750 revolutions; grind about seven-eighths, or until the bran is thin and clean.

Fine grits may be made by using tail sheet of second or third reels, according to how fine they are desired.

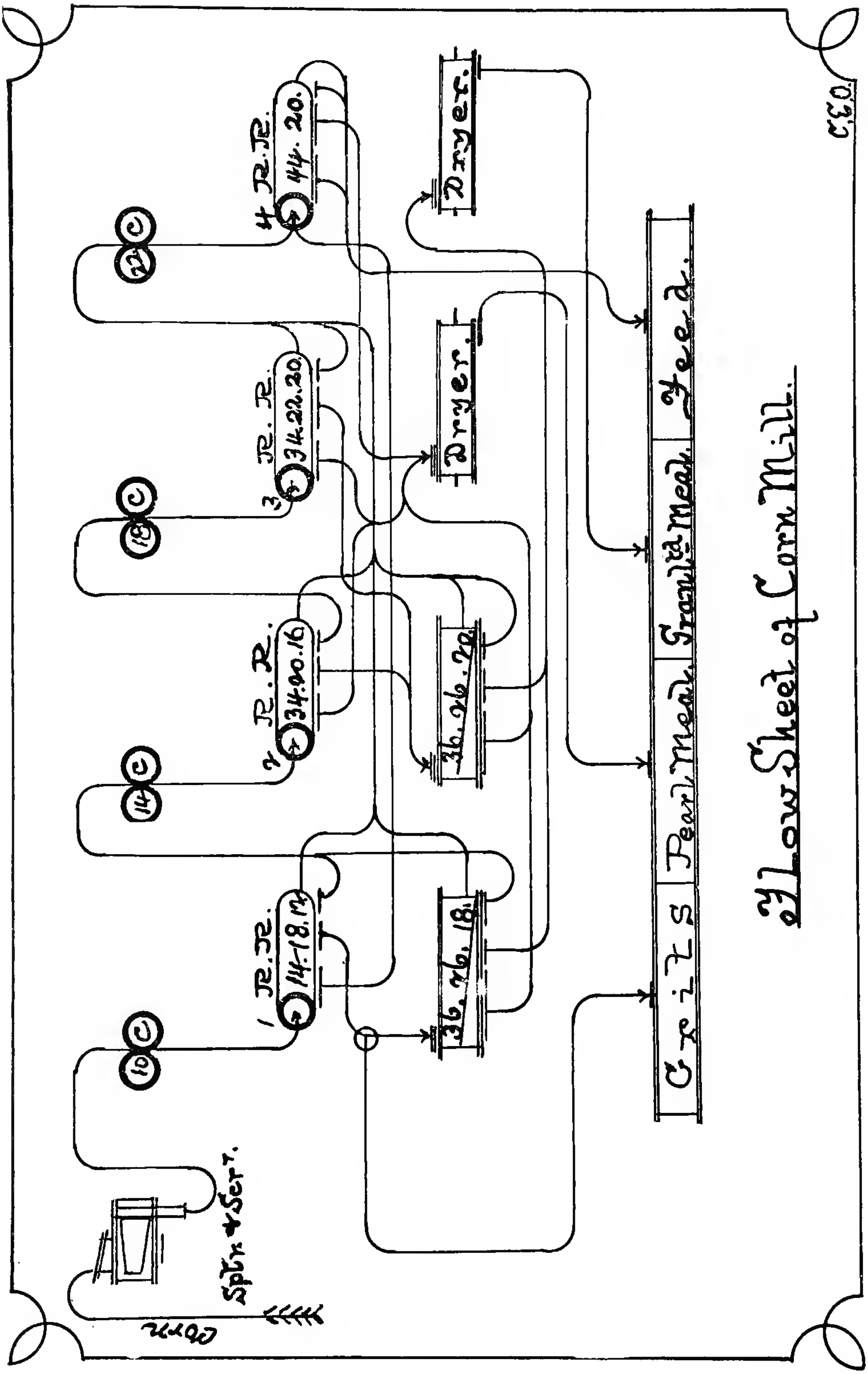

Flow Sheet of Corn Mill.
Grits
Pearl Meal
Granulated Meal
Feed.
Dryer.
Dryer.
1 R.R. 14.18.12.
2 R.R. 34.00.16.
3 R.R. 34.22.20.
4 R.R. 44.20.
36.26.18.
36.26.20.
C.E.O.
Corn

Fig. 59.

By using about 12 inches of No. 5 wire at the tail of first R. R. and cracking the corn on first break, about 50%, a very fine grade of cracked corn may be made, as it would be free from nubbins, etc.

To take the corn on the ear it would require a sheller and corn cleaner, and followed by a corn scourer or cleaner, and also a dryer if necessary, or it could be spouted past any of these machines when not required.

All the reels and purifiers ought to be clothed with coated wire cloth, which is sometime called plated wire, and which does not oxidize.

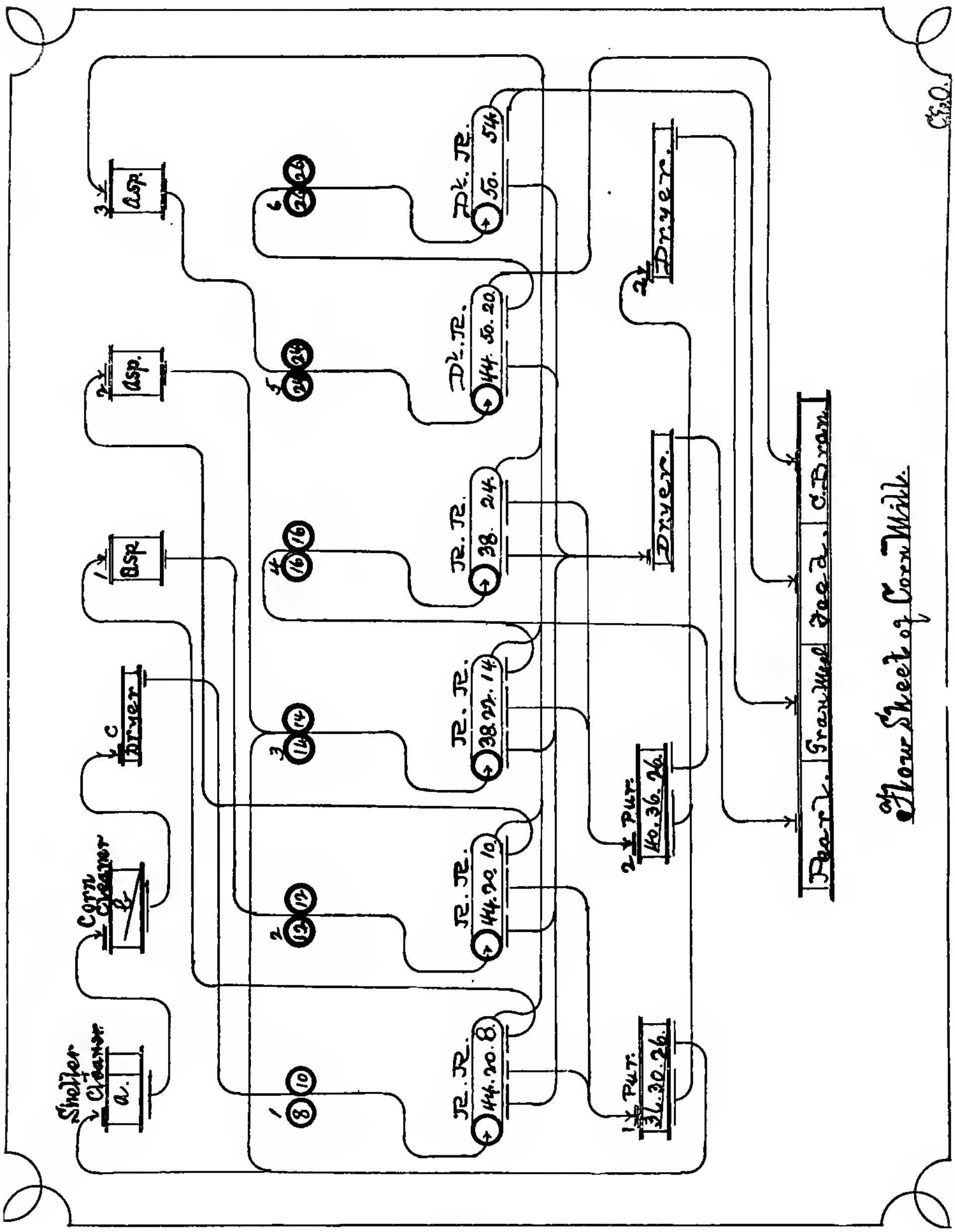


Fig. 60.

If the rolls are 9 x 18 run the fast roll 500 to 600 revolutions.

In Fig. 60 is illustrated a flow sheet of a complete modern corn plant in which the finest goods may be made.

This plant will make fine, medium and coarse cracked corn, pearl and granulated meal; fine, medium and coarse grits; fine and coarse feed meal, etc.

Machine marked "a" is a combined sheller and cleaner; machine "b" is a corn cleaner, or may be a scourer and separator combined, and "c" is a dryer when corn is very moist.

There are 6 rolls or 3 double stands of 9 x 18; 4 round reels; 2 differential reels; 2 purifiers and 2 dryers.

First break has corrugations: 8 for fast, 10 for slow roll; 500 to 600 revolutions for fast roll; 1-inch spiral same as them all; break about half when making cracked corn, so that it will be as large as possible, and sharp cut so that it will dust freely.

Second break has corrugations: 10 on fast, 12 on slow roll; differential same as first break which is 2 to 1; break about three-fifths the stock coming to it, or until it appears about half corn meal, sharp and granular.

The third break has corrugations 14 to each roll; differential 2½ to 1; break about three-fifths the stock feeding it.

The fourth has 16 cuts for each roll; differential 2½ to 1; crush about three-fourths, or just enough to shape the bran.

The fifth crush has 20 cuts, corrugations, grooves or flutes; differential 3 to 1; crush until bran is formed.

The sixth crush has 26 cuts, differential same as fifth, or 3 to 1; crush until the bran is clean.

All machines should be clothed with plated wire, and the purifiers on pearl or granulated meal may be clothed with Gritz Gauze if working on dry corn continually.

Capacity for rolls 6 inches in diameter is about the following:

Rolls 12 inches in length, meal 15 bus. per hour; feed 20 bus.
Rolls 15 inches in length, meal 20 bus. per hour; feed 30 bus.
Rolls 18 inches in length, meal 25 bus. per hour; feed 35 bus.

Capacity for rolls 9 inches in diameter:

Rolls 14 inches in length, meal 30 bus. per hour; feed 50 bus.
Rolls 18 inches in length, meal 45 bus. per hour; feed 65 bus.
Rolls 24 inches in length, meal 65 bus. per hour; feed 90 bus.
Rolls 30 inches in length, meal 80 bus. per hour; feed 110 bus.
Rolls 36 inches in length, meal 100 bus. per hour; feed 120 bus.

These capacities are for each flow approximately, and a 3-pair high roller mill has about the same capacity as given above, but the capacity depends a great deal upon the man in charge of the rolls, and the sharpness of the corrugations, for they will have almost double the capacity when very sharp, and will take almost 50% less power.

The aspirators are for removing all light fluff from the grits and broken corn, and assist in purification.

If there is no sale for the corn bran it may be cut up so fine on the last roll that it can be turned into the feed meal and sold at better price than the bran.

Tail sheet of No. 1 R. R. may be used for medium cracked corn.

Tail sheet of No. 2 R. R. may be used for fine cracked corn or grits. Tail sheet of No. 3 R. R. may be used for chick cracked corn or fine grits.

When desirable to make the different grades of cracked corn and grits at the same time, making both kinds of meal, it is necessary to grind on first three breaks as though milling for cracked corn only, then insert a small slide, or draw one or two slides at each section where these different products are made, only drawing a small portion from each machine, and in this way it will effect the flow very little.

The purifiers need to be used for granulated meal only, and they assist in making the finest meal possible to make on any machine.

When kiln dried meal is required it is well to use all the dryers to insure the keeping qualities of the meal.

The flow may be made to produce almost any capacity by doubling on the machinery indefinitely.

There is no definite statement regarding the actual horse power that roller mills require for certain work performed.

The approximate horse power for feed grinding is about 7 bushels per horse power; for coarse grinding, and five bushels per horse power for fine grinding.

In Fig. 100 there is a method of making all kinds of meal; cracked corn, feeds, graham and wholewheat flour in a simple and inexpensive way.

Chapter XLV.

We now come to that part of milling that really belongs to all small mills, and many of the larger ones to assist in making them profitable.

When a mill fails to make almost all the products that a farmer requires in the way of feeds for cattle and poultry they pass the mill by even for their flour supply and get it where they may be able to get all they desire.

There are many millers who know little of anything regarding the manufacture of many kinds of feed, and it is my object in this chapter to assist the small miller to make his mill more profitable, and to show the headmillers how to make the mill he is operating more profitable to his employer.

In Fig. 61 is represented a flow sheet upon which it is possible to make almost all kinds of feed, meals, and flours of dark variety.

No. 1 is a combined separator and scourer adapted to clean either corn or other varieties of grain before it passes to the grinder.

In all kinds of feed milling the grain ought to pass a magnet to remove every piece of metal, for the reason that metal is very injurious to machinery, and is very dangerous regarding fire, very often sparking at the rolls and igniting the dust, causing an explosion, and often destroying the mill.

No. 2 is a 3-pair roller feed mill, or 3-high mill as I always designated them; and here may be used a 2-pair high roller feed mill when necessary, corrugating the fast roll on first break 10 per inch; and the slow roll 12 per inch, and the fast roll on second break 20 per inch, and the slow roll 22 per inch.

Fast roll on first break 700 revolutions for 6-inch roll, and slow roll 300.

Fast roll on second break 750 revolutions per minute; slow roll 250 revolutions per minute.

When using 9-inch rolls reduce the speed about 25 per cent.

No. 3 is an attrition mill which can be used for almost anything, yet to my idea it will never take the place of a good 3-high roller mill for all around purposes, and there is nothing that is more economical in power than the rolls when they are kept sharp.

By having the "V" shaped tooth the rolls may be changed when dull on the one edge of the cuts, making them available almost double the length of time without re-corrugating, which is quite a saving.

When necessary to grind the corn on the cob a special corn and cob mill must be installed.

No. 4 is a round or hexigan reel, and which should be clothed with plated wire cloth to prevent oxidization by the dampness "at various seasons" of the grain that will have to be ground.

By making cracked corn on the tail sheet and running everything larger over the tail it makes a grade that is hard to beat, and making almost every grain the same size, and making it sell for more money.

Feed milling is becoming a fine art, and the more it is studied the more one

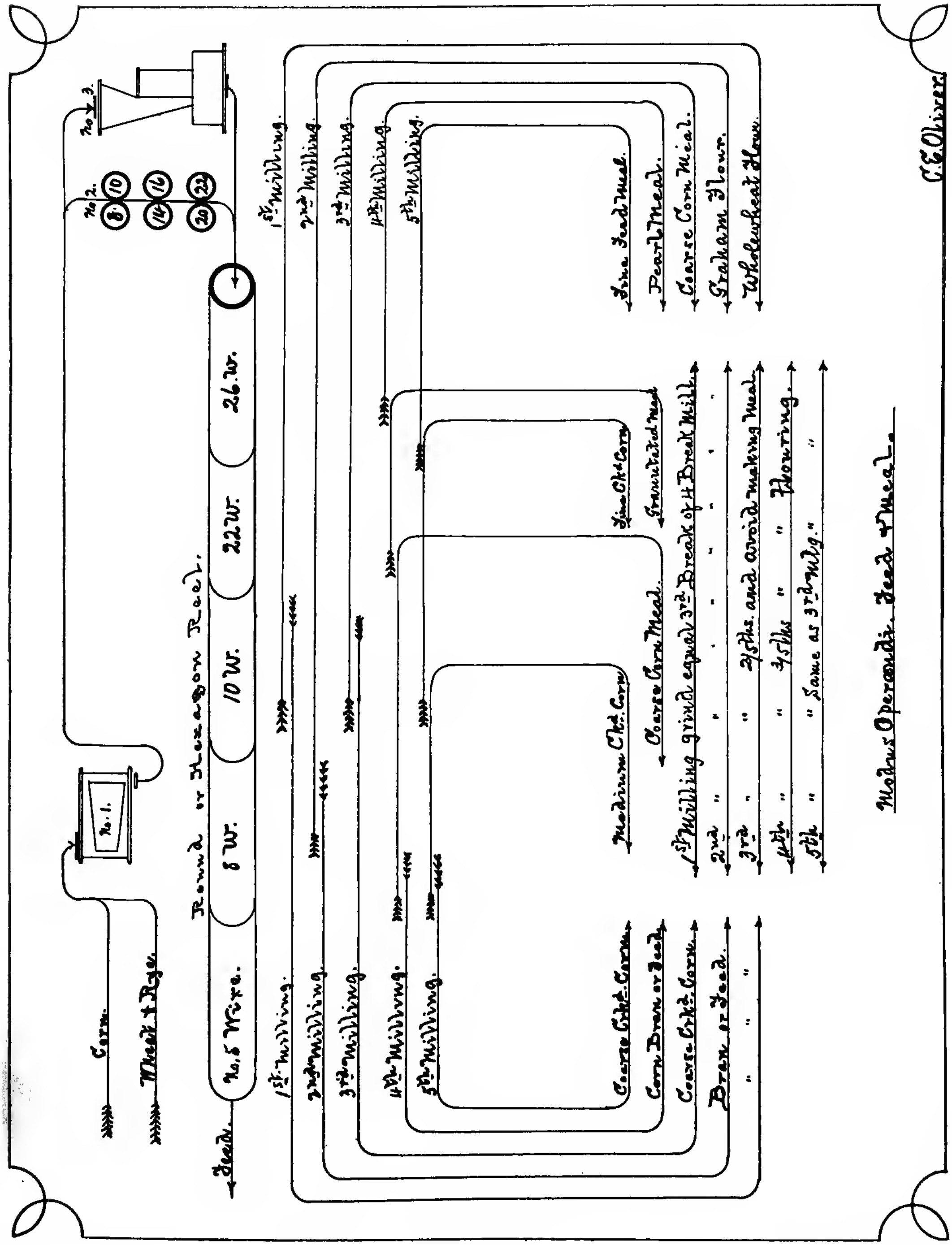

Round or Hexagon Reel.
No. 5 Wire.
8 W.
10 W.
22 W.
26 W.
Feed.
Corn.
Wheat & Rye.
No. 1.
No. 2.
No. 3.
8
10
14
16
20
22
1st Milling.
2nd Milling.
3rd Milling.
4th Milling.
5th Milling.
Coarse Ckd. Corn.
Corn Bran or Feed.
Coarse Ckd. Corn.
Bran or Feed.
Medium Ckd. Corn
Coarse Corn Meal.
Fine Ckd. Corn
Granulated Meal
Fine Feed Meal.
Pearl Meal.
Coarse Corn Meal.
Graham Flour.
Wholewheat Flour.
1st Milling grind equal 3rd Break of 4 Break Mill.
2nd " " " " " " " "
3rd " " 2/5ths. and avoid making meal.
4th " " 3/5ths " " Flouring.
5th " " Same as 3rd mlg.
Modus Operandi. Feed & Meal.
C.E. Oliver.

Fig. 61.

becomes fascinated with it, and the better pains taken with the manufacture, the more the profit in the goods.

The reel ought to be made almost exclusively of iron, or it will wear out very rapidly by the cutting action of the various coarse material passing through it.

To make the various goods named on the flow it is necessary to make them at different times as will be noted by the instructions on the flow proper, and which I believe will readily be understood by anyone understanding milling.

A reel 10 feet in length would be the best for this purpose, but they are very difficult to obtain, and so it will be necessary to use 6, 7 or 8 feet reels as necessary to meet the capacity of the rolls being used.

A reel with double conveyors is absolutely necessary to get the various combinations, and the operative must so arrange the spouts leading from those conveyors in order to take them off as desired.

At one milling there can be made pearl meal, granulated meal, chick cracked corn, and coarse cracked corn, and which is more economical than having to make all at different grindings.

The author has made with this outfit all the products mentioned above, so he knows whereof he speaks when he says that very fine goods can be produced when care is exercised in the milling.

To make scratch feed by machinery it is necessary to have the bins over a conveyor, when by careful manipulation all the spouts may be arranged to feed the various products in proportion that are required.

It is very easy to crack corn, make scratch feed, and take in grain at one and the same time in a very small mill by careful planning and arranging of the machinery.

Please bear in mind that there is no economy in milling with dull corrugations, for it makes mush of the stock, it prevents the products being their best, and it is a waste of power.

Chapter XLVI.

RYE MILLING.

It was not my intention to go into rye flour manufacture, but the calls for assistance from small millers have been so frequent that I decided to give a small space to this subject, and trust I make it clear to my readers.

In Fig. 62 is illustrated the flow sheet that may be used for any capacity according to the size of machinery used, and the rolls may be used any size from 6 x 12 to 10 x 42, and the purifiers and bolters may be doubled several times if desired.

For very small mills a very much reduced flow sheet may be used, in fact the rye flour for country trade may be made on the flow shown in Fig. 100 by having the head sheet No. 70 wire, when it may be used for buckwheat and rye flour, and yet be used for dusting the other feed bolted thereon.

The capacity of this flow is 50 to 75 barrels, according to the moisture content of the rye being ground.

No. 1 is a combination separator and scourer, and as rye flour does not have to be as white as wheat flour, it is not necessary to scour the grain so much.

The 1st break has 12 corrugations, differential 2 to 1; fast roll 700 revolutions, rolls 6 x 15, break about 50% or half; and have the "V" corrugation, and 1-inch spiral on all the breaks.

The 2nd break has 18 cuts per inch, differenital 2½ to 1; rolls 6 x 15, break about three-fourths, or until bran is shaped, but not too close to make mush out of the stock, for it is very particular to keep the meal lively in order to bolt freely.

The 3rd break has 24 corrugations, differential 3 to 1; break until the feed is clean, for it can scarcely be called bran on account of its chipping nature, being very brittle.

All rolls in this flow are 6 x 15, and speed of fast roll on each pair should be 600 to 700 revolutions per minute, and up to 750 if capacity only is to be considered.

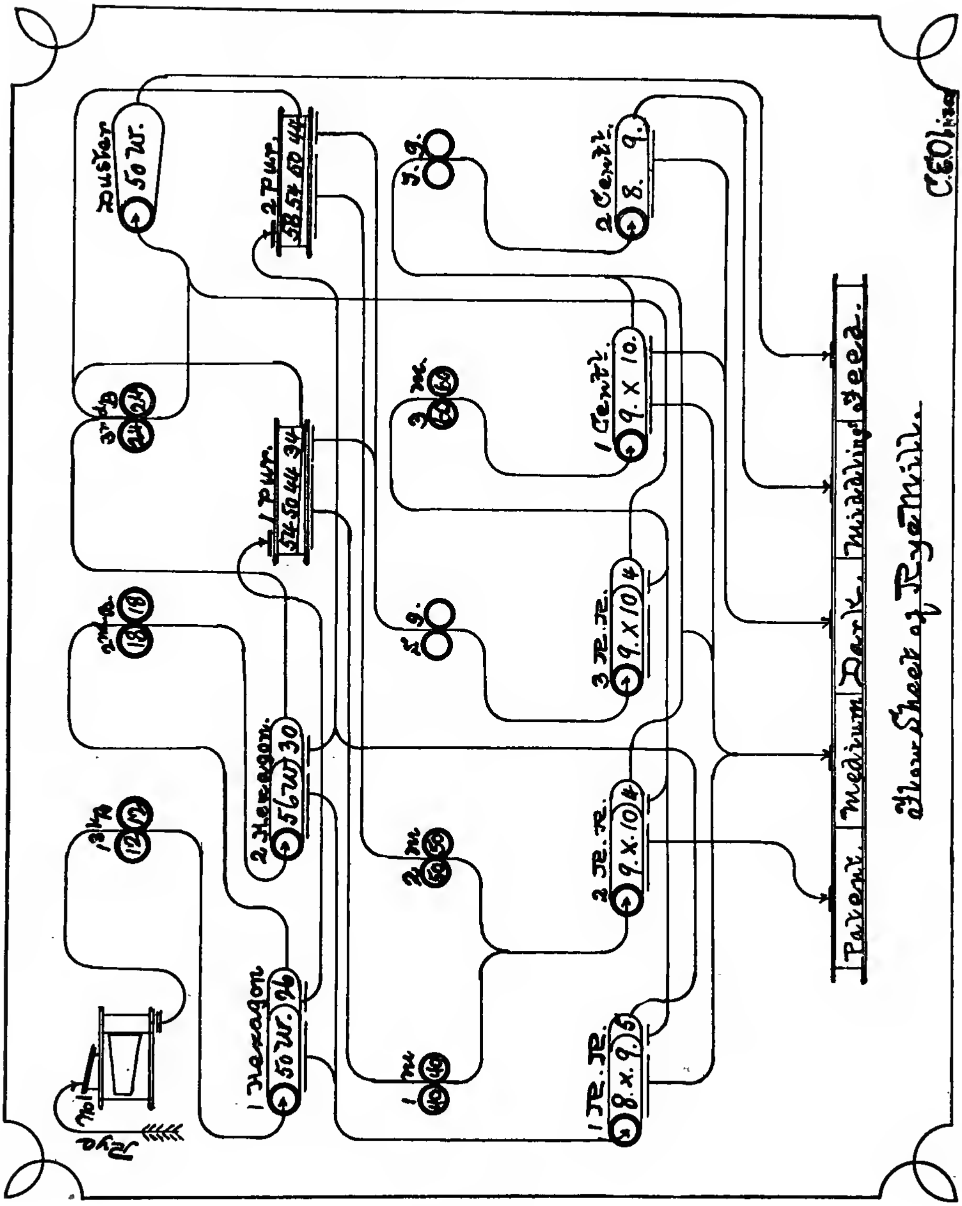


Fig. 62.

The feed duster may be a regular ships duster used by almost all mill builders, and clothed with No. 50 wire.

The scalpers may be hexagon or round reels, clothed with wire, and ought to have automatic wipers attached to keep the meshes open.

The cloth may be tapped lightly with a thin wire at intervals, or with a slender switch, which is really better than wire, for should it fall into the machine conveyor it can do very little damage.

By tapping the cloth it loosens the grits, and they fall out of the meshes.

A good wiper is a gunny sack tacked in such a manner to the frame that it touches the cylinder of the reel as it revolves, and keeps it fairly clean.

The purifiers may be clothed with G. G. or silk bolting cloth, and they must be kept clean, the feed covering the entire cloth from side to side; the air currents passing without obstruction to the fan, and the stock traveling in a thin even sheet over the whole cloth.

No. 1 middlings roll has 40 corrugations, differential 2 to 1; grind until the stock is smooth and mealy, and just warm.

Roll No. 2 is the 2nd middlings roll, it has 50 corrugations, differential 2 to 1; grind until stock is smooth and mealy, and just warm to the touch.

The 3rd roll is the sizing roll, differential 2½ to 1; grind until the stock is smooth, which is not really sizing, but the system is so short that it is necessary to grind close on the sizing rolls in order to get a clean up.

The 3rd middlings roll has 60 corrugations, differential 2½ to 1; grind until the stock is smooth and warm to the touch, but never until it is greasy.

The tailings roll has differential of 3 to 1, and grind until the stock is smooth and warm to the touch.

It is not necessary to grind any of the rye stock until it is red hot to the touch, or yet greasy, or flaked, or it will be the cause of a very poor yield.

The flouring reels and centrifugals ought to be clothed with silk bolting cloth to do the best work, and the meshes must be kept open.

It is possible with this flow sheet to make three grades of rye flour as shown, and these three grades may be turned into blended rye flour by having the mixers arranged to feed flour into any one of them.

To make a straight grade of rye flour it is necessary to turn all the flour slides into the one spout.

Regulate the patent with the medium, the medium with the dark, and the dark with the feed.

To make rye meal arrange the 1st and 3rd break rolls so that the rye may be run through each of them without bolting; grind on 1st break about three-fifths, and on the last until it is smooth; this stock is also called pumpernickel by the German people.

The middlings and bran is often run together and named rye feed.

Rye flour may be made on a burr mill by grinding right down, and sending the stock over a bolter clothed with No. 9 cloth, sending the feed to the packer direct.

The yield on this last method will be difficult, but it will do for a purpose when there is no other machinery available which so often happens.

Two breaks and three reductions make a very good flour for rye where close yields are not looked for, or yet the finest quality goods.

The flow sheet presented in Fig. 62 will make very fine goods when the mill is run by someone who knows how to run a mill and make rye flour for the various demands of the trade, for those demands are so varied that one never knows how to mill to please so many different demands.

At the present time in my business I am handling no less than ten different kinds of rye flour, and yet there are calls for some kind we do not have in stock.

A five or six section sifter may be used in the flow presented in Fig. 62 to good advantage, as it would be a saver of space, money and power, and would give better yield and quality, but some object to the sifter for ceeral milling on account of the inaccessability of the machine while in motion.

A bushel of rye weighs 56 pounds.

The yield is 26 to 40 pounds of flour per bushel.

The analysis of rye is approximately the following:

Water 12.4 per cent.; crude ash 1.9 per cent.; crude protein 10.7 per cent.; crude fat 1.6 per cent.; crude fiber 2.3 per cent.; nitrogen free extract 71.1 per cent., totaling 100 per cent.

CHAPTER XLVII.

BUCKWHEAT MILLING AND FLOW SHEET.

I had not intended to say anything about buckwheat milling, but same as the rest I was pestered to death with letters asking for information regarding this subject, so that it decided me in its favor.

In Fig. 63 is presented a flow sheet that may be arranged to any capacity up to 500 barrels daily by increasing the size of the machines, and doubling up on the number of machines to be used the same as in rye milling.

This flow is to make 75 to 100 barrels of straight grade buckwheat flour, and it will be of the very best providing the buckwheat being milled is sound in quality.

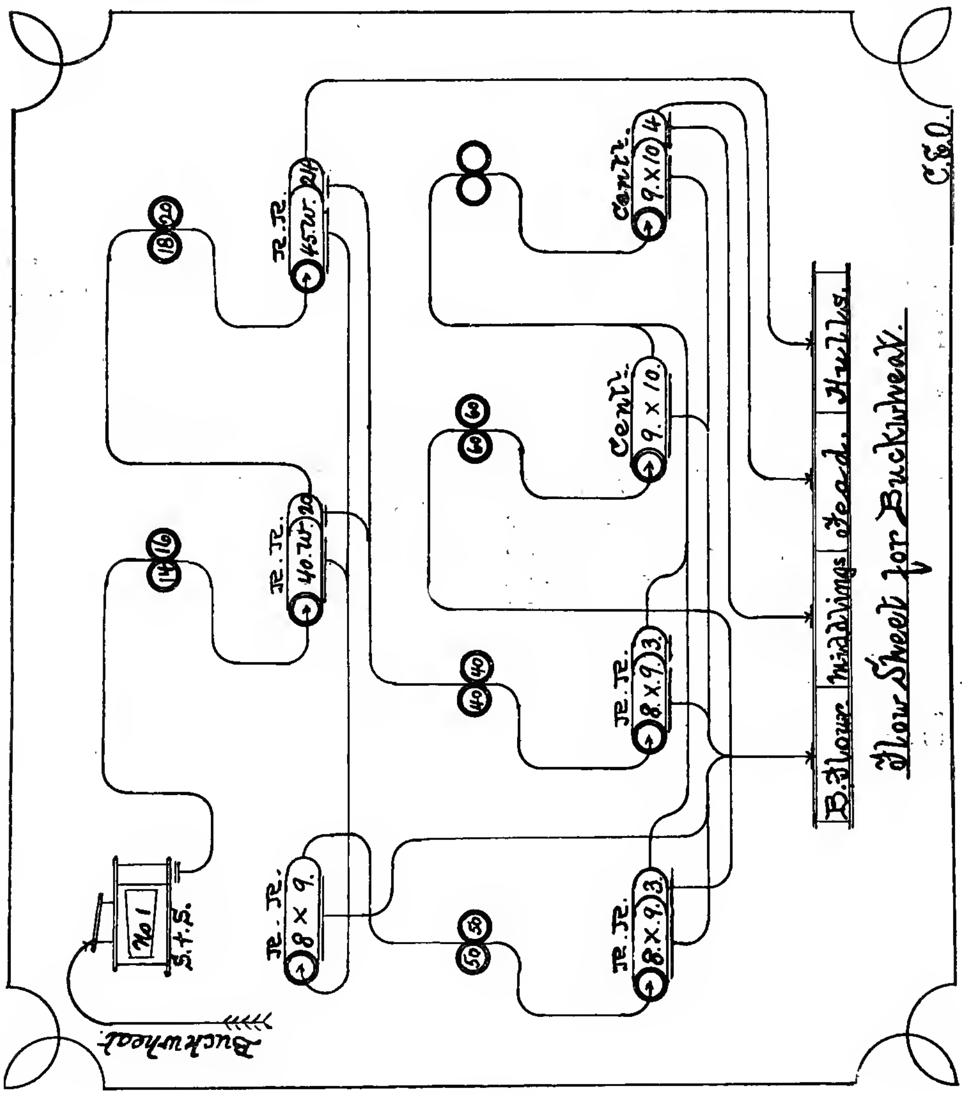


Fig. 63.

There are two breaks and four reductions, all rolls 7 x 18; scalpers may be hexagon or round reels; then there are three reels and two centrifugals.

Buckwheat milling is the same as rye milling, it not being necessary to have purifiers, as the flour is generally dark, yet in rye milling people are becoming more exacting, and demanding rye flour to be made whiter, and so the millers have to cater to their tastes by making patent rye flour, and the sale of it is increasing very rapidly.

It is not necessary to clean buckwheat so much, and a combination separator and scourer is sufficient for this purpose unless it is very dirty, when it may be scoured twice.

The 1st break fast roll has 14 corrugations, runs 600 revolutions; spiral on all rolls one inch per foot; slow roll 16 corrugations; running 240 revolutions, which gives a differential of 2½ to 1.

The 2nd and last break has 18 corrugations for fast roll; runs 600 revolutions; slow roll has 20 corrugations, cuts, flutes or grooves, and runs 200 revolutions, which gives a differential of 3 to 1.

The rolls may be run up to 700 revolutions when capacity alone is sought, but it is poor policy, for it consumes power, increases the noise, and cuts up the stock, and it is necessary to be more particular in the roll adjustments.

The scalpers are clothed with plated wire cloth, and the rest of the machines with silk, multi-metal or Adamesh cloth, and it is up to the owner to choose the cloth he prefers, for under various conditions for feed and cereal milling I would advise the metal cloths.

Buckwheat may be made on one roll and followed by burr, with rolls to take the middlings; and it can be made on a two or three high roller mill, using a bran duster clothed with No. 70 wire for the flour, and 9-inch strip at the tail for middlings of No. 30 wire; the brushes on machine to run about 200 revolutions.

A centrifugal clothed the same will answer the same purpose, and reel will do where capacity is small, and nothing else is available.

It is an easy matter for an ingenious miller to fit up a rig to mill feed, rye and buckwheat providing he has any old machinery lying around, and it is astonishing what palatable food can be made from these old contraptions when a man is practical in milling, and will get his brains to working out things.

There is always a way out of a tight place if millers will only look around, and not get discouraged and disgusted at the first obstacle.

The yield from Japanese buckwheat is from 28 to 36 pounds of flour; from 35 to 43 from Silver Hull, the milling of this is the same as flour milling, all kinds of yields being made.

The bushel of buckwheat is 48 pounds.

The constituents of buckwheat are approximately the following: 8.9 per cent. water; 1.8 per cent. crude fat; 11.5 per cent. crude protein; 2.9 per cent. crude fat; 10.5 per cent. crude fibre; 64.3 per cent. nitrogen free extract, totalling 100 per cent.

Chapter XLVIII.

THE WEIGHT PER BUSHEL.

This is a problem which causes much annoyance to all those in the grain business, and how easily it could be remedied if the governments in the world could open a court of adjustment of our weights and measures, and make all to be governed by the metric system.

Why should it be so that we have to rack our brains to remember the different weight per bushel of each kind of grain when it could be so easily handled by the 100 bushel measure or parts thereof.

In the following table is given the weight per bushel of grain in different states which I trust will be of service to the dusty brethern, and let us urge upon everyone in the grain and milling business to speak of changing to the metric system, for it would benefit all in so many ways.

The following table gives the legal weight in pounds per bushel in different states:

STATES	Wheat	Rye	Oats	Barley	Buckwheat	Shelled Corn	Ear Corn	Corn Meal	Beans	Peas	Flax Seed	Timothy Seed	Clover Seed
Arkansas	60	56	32	48	52	....	70	50	60	46	56	45	60
California	60	54	32	50	40	52	....	....	....	....	....	....	....
Connecticut	60	56	32	48	48	56	....	50	60	60	....	....	....
Georgia	60	56	32	47	52	56	70	48	60	60	56	48	60
Illinois	60	56	32	48	52	56	70	48	60	....	56	45	60
Indiana	60	56	32	48	50	56	68	50	60	....	....	45	60
Iowa	60	56	32	48	52	56	70	....	60	....	56	45	60
Kansas	60	56	32	48	50	56	70	50	60	....	56	45	60
Kentucky	60	56	32	47	55	56	70	50	60	60	56	45	60
Maine	60	56	30	48	48	56	....	50	64	60	....	....	....
Massachusetts	60	56	32	48	48	56	....	50	....	....	....	....	....
Michigan	60	56	32	48	48	56	70	50	60	60	56	45	60
Minnesota	60	56	32	48	42	56	....	....	....	....	....	45	60
Missouri	60	56	32	48	52	56	....	....	60	....	56	45	60
New Hampshire	60	56	32	....	....	56	....	50	60	60	....	....	....
New Jersey	60	56	32	48	50	56	....	....	60	60	55	....	64
New York	60	56	32	48	48	56	....	....	62	60	55	44	60
North Carolina	60	56	30	48	50	54	....	46	....	50	....	....	64
Ohio	60	56	33	48	50	56	70	....	60	60	56	45	60
Pennsylvania	60	56	32	47	48	56	....	....	....	....	....	....	62
Rhode Island	60	56	32	48	....	56	....	50	....	....	....	....	....
South Carolina	60	56	33	48	56	56	70	50	60	60	44	45	60
Tennessee	60	56	32	48	50	56	72	50	60	60	56	45	....
Vermont	60	56	32	48	46	52	....	....	60	60	....	45	60
Virginia	60	56	32	48	52	56	70	50	60	60	56	45	60
Wisconsin	60	56	32	48	50	56	70	....	60	....	56	45	60

CHAPTER XLIX.

ELECTRIC LIGHT.

Every mill having a few horse power to spare, and which has to run overtime or at night, should by all means put in a small electric light plant. They may be put in from twenty lights up, and are the most convenient, safe, and economical lights for a mill.

They give off no heat to speak of. There is no danger from fire if put in by a responsible man who understands electricity and knows the number of amperes each wire is capable of carrying.

The wires are dangerous if too small, or if they are not properly insulated; but inside of that there is little to fear, and a man may soon be able to run a plant in connection with a mill.

The writer has built a number of mills in which he placed electric light plants and the owners would just as soon sell the mills as part with the electric light.

About one horse power is required for every ten incandescent lights of sixteen candle power each, and by running the dynamo at the specified voltage the lamps are of small expense.

The lamps, when shaded, give a far-reaching light, and being enclosed, may be placed inside purifiers, carried in the hand to look over bolters, do repairs, and may be placed in a cloud of dust without fear of an explosion.

Lamps may be connected in series, or single, and the lights on each floor of the mill may be operated by a single switch, placed at the top of each pair of stairs, so that the miller ascending may turn on the lights, and when descending shut them all off, thereby affecting a saving.

The dynamo may be driven by turbine, engine, line shaft, counter shaft, etc.

In mills of fair size it is policy to have separate power for operating the lights, so that they may be used when the mill has to shut down at any time.

The electrical units are as follows:

The ohm is the unit of resistance, symbol R, and is obtained by the electrical resistance of a column of mercury 106 centimeters long and one square milimetre section.

One true ohm equals 1.0112.

British Association ohms.

The ampere, symbol C, is the unit of current, and is obtained by that current of electricity which decomposes .00000324 grammes of water per second.

The volt, symbol E, M, F, is the unit of electro motive force, and is obtained by one ampere of current passing through a substance of one ohm of resistance.

The column, symbol 2, is the unit of quantity, and is obtained by a current of one ampere during one second of time.

The farad, symbol H, is the unit of capacity and is the capacity that a current of one ampere for one second (equal one colomb) charges it to potential of one volt.

A micro-farad is one-millinoth of a farad.

The watt, symbol P, W, is the unit of power, and is obtained by one ampere of current passing through one ohm of resistance.

The jon, symbol W, J, is the unit of work, and is the work done by one watt of electrical power in one second.

Certainly no study is more intricate than that of electricity, though a man does not require much electrical knowledge in order to put an electric plant into a mill and run it.

Many will object to the installation of plant on the ground that it is dangerous, and a menace to human life, but on that score it may be stated that there is no danger. It takes a charge of 1,500 to 2,000 volts to kill a person, and any plant in a mill below 2,000 barrels capacity, will not require a voltage of more than 500.

A strong shock may be received by taking hold of the main wires leading from

the dynamo, but no one would be so foolish as to do this; and any injury received in this manner is a person's own fault.

A man may take hold of either the positive or the negative main wire without feeling anything if the wires are sufficiently large to carry the desired amperes of current, but if they become overcrowded they get hot, and, of course, will burn in proportion to the intensity of the heat. They may become so hot as to melt the wire, thereby cutting off the current. A person fooling around a plant with both hands will at times receive a shock.

Using the hands together forms a connection, thereby causing the current to pass through the body.

If a wire burns out, and the man takes the burnt wires, one in each hand, a connection is formed which will cause a slight shock. If this occurs on the main wires the shock will be so much more violent that it will not be forgotten by the person receiving it, and he will learn a valuable lesson thereby.

The writer has never heard of an accident in a mill which originated in the electric light. He has known of fire, but that was caused by putting double the number of amperes on a wire than it was able to carry, thereby causing it to fuse and set fire to something.

Lead fuses can be attached, so that when the voltage rises too high it will melt the fuse instead of blowing the lamp.

Have a small electric light plant in a mill, by all means, as it is perfectly safe in all respects when put in by a responsible person.

Patent fuses are now in general use to protect both the lamps, wires and motors, and save trouble and expense in repairing.

Chapter L.

BRUSHES AND SWEEPING.

The most economical and effective mill sweeping brush is the ones of pure bristles, for they will always sweep clean, and especially where there are hard wood floors.

Both the sweeping and the hand brushes ought to be of the same make, for while they are expensive at the first cost, they will if properly used outlast ten brooms, besides having the satisfaction of knowing that the mill is clean.

Buy those that have the best bristles, for there are some that are only imitation brushes, and are soon worn out, and when they are partly worn they are beyond use.

Do not use these brushes in wet or damp places, for they soon play out, and the bristles will bend over and stay that way, making them useless.

Never stand bristle brushes on the head, for they soon become useless by being bent one way; and the only thing for these brushes is to hang them up on two nails placed about two inches apart for that purpose, and they will always be ready for use.

The floor brushes are generally provided with two holes for the shank in order to be able to reverse the head and keep it straight.

These brushes may be used both pushing and pulling with equal facility, and this keeps the brush in better shape, and it will wear longer.

A floor can be swept with one of these brushes in about half the time it takes with a broom, and the floor is clean when it is swept, which gives much better satisfaction to the operator of the broom.

With a hand brush of the best bristles, the machinery can be kept very clean with little effort, and they are clean, but use one of the common kind and there will be disgust with it all.

After the machinery has been brushed, it is a good thing to rub them with a cloth, for this will give them a polish that will keep them equal to new machines.

Chapter LI.

FORMULAS, OR RECIPES FOR FEED.

Recipe for Scratch Feed for Poultry:

25 per cent. sifted cracked corn;
15 per cent. wheat which may be slightly off grade;
10 per cent. kaffir corn, white, red or mixed;
10 per cent. buckwheat, silver hull or Japanese;
15 per cent. barley;
10 per cent. wheat screenings, free from dust;
5 per cent. oats, clipped;
3 per cent. sunflower seeds;
2 per cent. ground oil cake;
2 per cent. ground bone or beef scraps;
2 per cent. charcoal, No. 4;
1 per cent. grit or oyster shells, No. 2.

When making this mixture by machinery the last five ingredients may be mixed and fed into the other by a feeder. This can be made on the floor by hand shovels more uniform than by machinery.

Recipe for Scratch Feed.

30 per cent. cracked corn, bolted;
20 per cent. barley;
10 per cent. screenings, wheat;
10 per cent. kaffir corn;
15 per cent. wheat;
5 per cent. buckwheat;
5 per cent. oats, clipped;
5 per cent. ground oil cake, grit, charcoal and sunflower seed.

Recipe for Scratch Feed.

30 per cent. cracked corn, bolted;
20 per cent. barley;
10 per cent. wheat;
10 per cent. kaffir corn;
10 per cent. rye;
10 per cent. buckwheat;
5 per cent. screenings;
2 per cent. ground bone;
1 per cent. oyster shells or grit, No. 2;
1 per cent. charcoal, No. 4;
1 per cent. sunflower seeds.

Recipe for Scratch Feed for Close Competition.

50 per cent. cracked corn, sifted for Close Competition;
20 per cent. wheat screenings;
10 per cent. barley;
5 per cent. wheat;
5 per cent. kaffir corn;
5 per cent. buckwheat;
2 per cent. beef scrap or ground bone;
2 per cent. grit and charcoal, Nos. 2 and 4;
1 per cent. sunflower seeds.

Recipe for Scratch Feed for Very Close Competition.

60 per cent. cracked corn; off grade, Close Competition;
10 per cent barley;
10 per cent. screenings;
5 per cent. wheat;
5 per cent. kaffir corn;
5 per cent. buckwheat;

Recipe for Chic Feed.

30 per cent. corn, white or yellow;
20 per cent. wheat;
10 per cent. kaffir corn.

Crack the above on feed roll or chopper about two-thirds; send to reel clothed 26, 22, 10 dustings of first part of 26 use for chicken mash with regrinding of siftings of Nos. 5 and 8. The reel is numbered 26, 22, 10, 8, 5; head to tail.

Mix siftings of 26, 22 and part of 10 with the following ingredients:

12 per cent. steel cut oatmeal;
10 per cent. millet, Imperial;
10 per cent. fine screenings;
3 per cent. fine or No. 3 grit or oyster shells;
3 per cent. fine charcoal;
2 per cent. fine granulated bone.

This is a very fine feed for chicks after six weeks old.

Recipe for Chicken Mash or Laying Food.

35 per cent. coarse corn meal;
10 per cent. bran;
20 per cent. coarse middlings;
10 per cent. ground oats;
10 per cent. ground barley;
5 per cent. cut clover or alfalfa meal;
5 per cent. beef scraps, bone, fish meat or blood meal;
2 per cent. cottonseed meal;
2 per cent. gluten meal;
1 per cent. fine grit and charcoal.

Recipe for Chicken Mash or Egg Food.

40 per cent. coarse corn meal;
20 per cent. coarse middlings;
10 per cent. ground barley;
10 per cent. ground oats;
5 per cent. clover or alfalfa meal;
5 per cent. gluten meal;
5 per cent. beef scraps, bone, fish bone or meat, blood meal;
3 per cent. cottonseed meal;
1 per cent. Fine grit;
1 per cent. fine charcoal.

Recipe for Pigeon Feed.

30 per cent. sifted cracked corn thru No. 6 wire;
25 per cent. wheat;
20 per cent. kaffir corn;
10 per cent. good screenings;
5 per cent. hemp seed;
5 per cent. millet seed, Imperial;
4 per cent. Canadian peas;
1 per cent. grit and charcoal.

Recipe for Duck Feed.

30 per cent. cracked corn;
25 per cent. wheat;
20 per cent. barley;
10 per cent. rye:
10 per cent. oats;
3 per cent. ground oil cake;
2 per cent. grit or oyster shells.

Recipe for Duck Mash.

30 per cent. coarse corn meal;
25 per cent. coarse middlings and bran; mixed feed;
15 per cent. ground barley;
10 per cent. ground oats;
7 per cent. rye meal;
5 per cent. alfalfa meal;
5 per cent. beef scraps, beef meal or blood meal;
3 per cent. oil or cottonseed meal.

Recipe for Horse Chop.

40 per cent. corn;
20 per cent. oats;
10 per cent. barley;
10 per cent. bran;
10 per cent. coarse middlings;
3 per cent. oil or cottonseed meal;
7 per cent. gluten meal.
Don't grind too fine.

Recipe for Horse Chop.

Receipt for pure Horse Chop:
40 per cent. corn;
38 per cent. oats;
Don't grind too fine.
10 per cent. barley;
10 per cent. rye;
2 per cent. oil or cottonseed meal.

Recipe for Horse Chop.

40 per cent. corn;
18 per cent. barley;
40 per cent. oats;
2 per cent. cottonseed meal.

Recipe for Horse Chop.

50 per cent. oats;
18 per cent. bran and middlings;
30 per cent. corn;
2 per cent. cottonseed meal.
Grind about as fine as coarse corn meal.

Recipe for Horse Chop to Meet Competition.

40 per cent. corn bran;
25 per cent. oat hulls;
5 per cent. middlings and cotton seed meal.
20 per cent. corn meal;
10 per cent. ground oats;

Recipe for Horse Chop to Meet Competition.

45 per cent. corn bran;
20 per cent. mixed feed;
5 per cent. cottonseed meal;
25 per cent. oat hulls;
5 per cent. barley screenings.

Grind fine as fine corn meal, or pulverize it so as to get rid of the sharp oat hulls.

Rolled or fluted oats make excellent feed for horses, and barley can be blended with them to good advantage. To flake, crush, roll or flute oats the rolls must run the same speed so as to squeeze but not grind or mash. It can be done on feed rolls by getting them up to speed with the feed on and then knocking off the slow side belt when they can be adjusted to suit. Great care must be taken or the corrugations will be injured in starting up.

Hog Feed for Fattening.

40 per cent. coarse corn meal, ground fine;
35 per cent. fine middlings;
22 per cent. fine barley meal;
3 per cent. cottonseed meal.

Put dishwashings and all kitchen slop into a good stout barrel and mix in the above mixture until it is a medium batter, then feed in quantities as desired. If it gets sour so much the better.

Recipe for Cow Feed.

30 per cent. coarse corn meal;
25 per cent. coarse middlings;
10 per cent. bran;
5 per cent. cottonseed meal;
10 per cent. hominy feed;
10 per cent. gluten meal;
10 per cent. barley meal.

Grind as fine as coarse corn meal or make it out of the various meals ready ground.

Recipe for Cow Feed more Profitable to Millers.

40 per cent. corn;
10 per cent. barley;
30 per cent. bran and middlings;
10 per cent. oats;
10 per cent. rye.

Grind about equal to coarse corn meal, and serve just damp.

Recipe for Cow Feed.

50 per cent. corn;
10 per cent. oats;
30 per cent. bran and middlings;
10 per cent. gluten meal.

Grind down about two-thirds.

Every mill has a different outfit for the making of feed, so that it would be impossible for me to give plans for the making of the different feeds in this book, but I can furnish any with plans upon application to me, and at reasonable prices.

A conveyor with the flights slightly changed from their conveying position makes a fine mixer for concentrated feed.

An old reel also makes a fine mixer for feeds. Chicken feeds may be made direct to an elevator.

Recipe for Wholewheat Flour.

Grind perfectly clean wheat, "white wheat if possible," grind on burr or 2 or 3 high roll, not too fine, or say about equal to coarse corn meal. Bolt on reel clothed with No. 18 to 20 wire, and the throughs will be as fine a wholewheat or entire wheat flour as can be made.

Recipe for Hand Mixed Wholewheat Flour.

40 per cent. straight flour;
30 per cent. first clear;
20 per cent. coarse middlings;
10 per cent. fine middlings..

Recipe for Graham Flour.

Grind perfectly clean wheat on burr or 2 or 3 high feed roll, and use all the rolls, grinding the stock as fine as coarse finished middlings, and leave it unbolted. Do not have the bran to coarse, and it is better to have perfectly dry and brittle wheat.

Recipe for Rye Meal.

Grind clean rye on burr or feed mill, or 2 or 3 high roll; grind as fine as stock from germ rolls and bolt over No. 20 wire cloth; or it may be left unbolted. To make it darker you may mix into it about 10 to 20 per cent. of low grade flour or fine white middlings.

Recipe for Pancake Flour.

Mix the following:

50 per cent. white corn flour;
30 per cent. good wheat flour;
20 per cent. rice flour.

Recipe for Pancake Flour.

Mix the following:

40 per cent. white corn flour;
35 per cent. straight wheat flour;
25 per cent. first clear.

Self Rising Pancake Flour for Winter Use.

Mix the following:

60 per cent. buckwheat flour;
20 per cent. white corn flour;
11½ per cent. first clear flour;
4½ per cent. phosphate soda;
2 per cent. soda;
2 per cent salt.

Self Rising Buckwheat Flour.

Mix the following:

75 per cent. buckwheat;
16½ per cent. first clear flour;
4½ per cent. phosphate soda;
2 per cent. soda;
2 per cent salt.

Self Rising Pancake Flour.

Mix the following:

35 per cent. white corn flour;
35 per cent. good wheat flour;
21½ per cent. rice flour;
4½ per cent. phosphate soda;
2 per cent. soda;
2 per cent salt.

Self Rising Pancake Flour for Summer Use.

Mix the following:

60 per cent. wholewheat flour through No. 60 wire;
20 per cent. white corn flour;
11½ per cent. first clear flour;
4½ per cent. phosphate soda;
2 per cent. soda;
2 per cent. salt.

Recipe for Corn Pancake Flour.

Mix the following:

80 per cent. white corn flour;
20 per cent. patent wheat flour.

Pure Buckwheat Flour.

Grind cleaned buckwheat on burr or 3 high feed mill using 1, 2 or 3 breaks as desired; grind fine enough to clean the bran; bolt on ships or bran duster clothed with No. 80 wire, the throughs being a fine grade of buckwheat. This is a crude outfit but the product is fine.

Recipe for Pure Buckwheat Flour.

Grind cleaned buckwheat on burr or roller 3 high mill, using as many breaks as desired to clean the bran and crush the midddlings; bolt on reel clothed with No. 80 wire at head, No. 20 at tail; the throughs at head to sack, the tail to roll; differential 3 to 1; bolt this on reel clothed with No. 9-XX bolting cloth, sifitings to sack. This will be very fine buckwheat. It may be improved greatly by blending in 20 to 30 per cent. of fine sharp middlings through No. 9 cloth, or patent flour.

All these feeds and cereals may be made by all small mills and sold as side lines, and which will make some profit providing good prices are asked for them.

Bran may be separated, taking the broad flakes and calling it domestic bran and sell it for five cents per pound, as I have seen it done.

Perfectly clean wheat I have seen sold in my city for five cents per pound as table wheat.

Wheat hearts may be made by inserting a tin spout about three inches wide underneath the first purifier sieve, and drawing out any grade desired; also wheat grits may be made in the same manner.

Recipe for Hog, Swine or Pig Feed.

20 per cent. corn or maize;
20 per cent. screenings "wheat";
15 per cent. rye;
10 per cent. oats;
10 per cent. barley;
10 per cent. malt sprouts;
10 per cent. cottonseed meal;
5 per cent. charcoal;
2 per cent. salt.

This is one of the finest feeds there is for pigs
Do not grind it too fine, about three-fourths is right.

Formula for Calf Meal.

40 per cent. fine middlings, pollard, ships or shorts;
35 per cent. coarse middlings, pollard, ships, sharps or shorts;
10 per cent. fine oatmeal;
10 per cent. flax seed meal, or linseed meal;
5 per cent. cottonseed meal.

This is a ready ration, and it will keep calfs in good condition.

Formula for Pigeon Feed.

20 per cent. sifted cracked corn or maize;
20 per cent. wheat;
20 per cent. Kaffir corn, red or white, or mixed;
10 per cent. hemp seed;
10 per cent. screenings "wheat";
10 per cent. cow peas;
5 per cent. buckwheat;
3 per cent. charcoal;
2 per cent. millet.

All grain products ought to be in bins above a conveyor, when slides may be arranged to mix the different quantities of each.

All grain ought to pass a separator in order to remove sticks, straws, etc., so as not to obstruct the free passage of the grain, or a perfect blend is out of the question.

Formula for Dairy Feed.

20 per cent. corn or maize;
10 per cent. oats;
10 per cent. rye;
10 per cent. mixed feed, bran and shorts, ships, sharps or pollard;
10 per cent. gluten feed;
10 per cent. malt sprouts;
10 per cent. alfalfa meal;
10 per cent. clover meal;
10 per cent. cottonseed meal.

This is a very fine feed for cattle of all kinds, and especially for milch cows, and if it is not possible to procure all the ingredients put in all possible and divide the others, but upon no account add to the cottonseed meal, for there is a limit to the cottonseed being fed to cattle.

Formula for Molasses Dairy Feed.

20 per cent. corn or maize;
15 per cent. oats;
10 per cent. clover meal;
10 per cent. barley;
10 per cent. alfalfa meal;
10 per cent. mixed feed, bran and shorts it means, ships, pollard;
5 per cent. cottonseed meal;
10 per cent. malt sprouts;
5 per cent. flax or linseed meal;
5 per cent. molasses, treacle, or syrup.

Mixed feed means bran and coarse middlings, shorts, ships, sharps or pollard mixed together.

This feed may be mixed and fed to all kinds of cattle, and it is a ready ration.

Formula for Cattle Regulator.

20 per cent. flax or linseed meal;
10 per cent. buckwheat sharps or shorts;
20 per cent. wheat coarse middlings, ships, shorts, pollard or germ middlings;
10 per cent. powdered charcoal;
8 per cent. common salt;
5 per cent. Fenugreek;
5 per cent. ginger;
5 per cent. gentian;
5 per cent. sulphur;
5 per cent. potassium nit;
5 per cent. copperass;
2 per cent. cayenne.

A tablespoonful of this is sufficient for a mixture of one feed, and only once daily for six days, then miss one week before giving more.

Formula for Poultry Regulator.

20 per cent. middlings "coarse," ships, shorts, sharps, or pollard;
20 per cent. buckwheat middlings, sharps, ships, or pollard;
10 per cent. cottonseed meal;
10 per cent. linseed or flax seed meal;
10 per cent. powdered charcoal;
5 per cent. blood meal;

5 per cent. common salt;
5 per cent. ginger;
5 per cent. sulphur;
5 per cent. copperass;
5 per cent. red pepper.

A tablespoonful once every other day mixed in the feed for fifty fowls. This keeps the fowls in the finest condition, and millers can make this product, and there is 300 per cent. profit to those who know how to do it.

Formula for Mule Feed.

20 per cent. corn or maize;
20 per cent. oats;
20 per cent. oat shorts, middlings, sharps, pollard;
10 per cent. corn or maize bran;
10 per cent. barley;
10 per cent. alfalfa meal;
5 per cent. mixed feed, which is bran and middlings mixed;
5 per cent. linseed or flax seed meal.

This is a ready ration, and it will keep a mule in the best of condition.

Each miller may choose his formula from amongst the number in this work, for I have tried to get those to fill the various conditions of the different localities.

CHAPTER LII.

INVOICES, ACCEPTANCES, SHIPPING BILLS, ETC.

Invoice for Miller.

Original Invoice: Shipper's No.................

.....................................Railroad. Invoice No.....................

Sold to Oliver Milling Co.,
Indianapolis, Ind.

Bought of PENN MILLING COMPANY,
Washington, D. C.

Date of Invoice.................................. Consigned to ....
Shipped .... Town ....
To .... State ....
Town .... Notify ....
State .... At .... State ....
Route...................... Draft No............. Rate............ Car Initial............ Car No.............

No. Packages	Size	Kind	BRAND	Tons	Lbs.	Price	Gross	Net

Terms:........ Applied on Purchase............ Sold F. O. B............. Payable Through........

NOTICE.—Claims for damage, shortage or overcharge in freight must be accompanied by original R. R. freight expense bill, with R. R. agent's notation, showing number of packages short or damaged.

Order Blank.

OLIVER MILLING COMPANY,

Indianapolis, Ind., U. S. A.

Order to	Date ....
Ship to	Order No. ....
Town............................ State..............	Shipping Date ....
Charge to	Route ....

All invoices to the above address. Please acknowledge order.

Please give date of shipment.

Letter Head.

Phone No. 000 Cable Address: Oliver.

Prices subject to market changes.

OLIVER MILLING AND FEED COMPANY.

Our goods are perfect

Daily Capacity 60,000 Barrels.

Our Noxemall Patent Flour is the Onliwon

All our goods are guaranteed satisfactory.

Indianapolis, Ind.,..............................19....

Mr. Henry H. Dean,
Washington, D. C.

Dear Sir:

Your valued favor of the 26th inst. received, etc.

Yours very truly,
Oliver Milling Co.,
Per.........................

This is about the form of letters to business men from business men.

Confirmation of Sale.

Original.

Phone No. 000 Cable Address: Oliver.

OLIVER MILLING COMPANY.

Daily Capacity 500 Barrels.

Indianapolis, Ind.,..................................19....

Messrs. or Mr..

At..

Sir or Gentlemen:

We beg to acknowledge with thanks your order through our Mr. W. R. Russell, dated.., 19........, as following:

No. Packages	BRANDS	Price	F. O. B.	Our Track	Your Track

Order No...................... Terms......................... Shipment When..

NOTICE.—Goods not ordered out in time specified will be subject to a charge of 5 cents per barrel or 25 cents per ton per month for each month or fraction thereof. This order is booked to be shipped and not cancelled, and the buyer is expected to receive it. We place goods on your track, but not delivered. No alterations of above contract permitted. No acknowledgement of verbal agreements between buyer and seller or their agents. This order is taken on basis of present freight rates. Our motto is, "Business on business principles; quick regulations of misunderstandings, and fulfillment of contracts literally."

It is the only business policy to acknowledge and confirm every order received, as it gives the buyer to understand that he is responsible for the giving of that order, and it can not be cancelled or repudiated, which is really a common practice, yet dying out, and that upon the awakening of conscience of business men.

Loading and Shipping Bill.

From

OLIVER MILLING COMPANY,

Indianapolis, Ind., U. S. A..............................., 19....

To..

Town..State..

Car Initial..................... Car No......................... Route..

No. Packages	Tons	Lbs.	BRANDS

NOTICE.—This car is loaded and checked by the undersigned. If not correct or there is damage in transit, do not fail to secure R. R. Agent's notation on expense bill. We are not responsible after receipt is taken from transportation company.

Loaded and checked by J. J Janes, J. J. Jones,

Employees of Oliver Milling Company.

Chapter LIII.

USEFUL HINTS TO OWNERS AND OPERATIVES.

Measuring Flour in Chest.

Flour when in a chest or bin weighs approximately 40 pounds per bushel. The flour content of one cubic foot in a chest or bin is about 32 pounds.

To find the flour content of bin or chest;

Multiply length by breadth, and then by depth in feet, then quotient by 32, which gives the flour content of bin in pounds.

Divide the product by 196 and the result is in barrels.

Divide the product by 280 pounds to get the contents in English sacks.

Divide by 240 and the result is in English packs.

To find approximate contents of corn, oats and chop bin:

Multiply length by breadth, and then by height in feet which gives the cubic feet; multiply quotient by 27, which gives contents in pounds.

If contents in 100 is desired strike off two decimals.

U. S. standard bushel contains 2150.42 cubic inches.

1 pound flour "wheat" equals 1 quart.

1 pound 2 ounces corn meal equals 1 quart.

Measurement of Grain.

The U. S. standard bushel is 2150.42 cubic inches. As a cubic foot is 1728 cubic inches, a cubic foot is nearly .8 of a bushel, it gives the mode of calculating grain.

To find the cubic feet of any bin, box, etc., multiply the length, breadth and depth together in feet, multiply the product by .8 and strike off one decimal, and you have the contents in bushels.

Example. To find bushels in bin 5 feet high, 4 feet wide and 6 feet long:

Arithmetically: $5 \times 4 \times 6 = 120$ cubic feet $\times .8 = 96.0$ bushels.

To be accurate add 1 bushel to every 297 cubic feet.

Another simple method in finding the contents of bin is to multiply the cubic feet by 5 and divide by 4.

Example. Bin 5 feet deep, 4 feet wide and 6 feet long:

Arithmetically: $5 \times 4 \times 6 = 120$ cubic feet $\div 5 \times 4 = 150$ bushels.

To find the contents of hoppered bottom bin, or any hopper:

Multiply the length by the breadth, then by one-third the depth to point of hopper in feet by 2150, and the remainder is in bushels that the bin holds.

To find the capacity of barrels:

Add together the diameter at the bung hole and the head, and divide by 2, which gives the average diameter, then multiply the average diameter by itself in inches, and then by the height in inches, then multiply the quotient by .000364, which gives the bushels contained.

When the measurements are in feet multiply the average diameter by diameter, then by depth, then by .63, which gives the bushels.

To find contents of ear corn in crib:

Multiply length, breadth and depth together for cubic feet; multiply by 4 and divide by 9.

To find the contents of crib 5 feet high, 5 feet wide and 5 feet long:

Arithmetically we have the following:

$$\frac{5 \times 5 \times 5 \times 4}{9} = 55.55 \text{ bushels ear corn.}$$

Shrinkage of Ear Corn.

Corn will shrink 20 per cent. in six months from time it is put into the crib at harvest, so that it does not pay the farmer to hold corn for a price.

Shrinkage of Wheat.

Wheat will shrink 6 per cent. in six months from the time it is placed in bin at harvest time. When buying wheat it is well to know approximately the amount of moisture content; in fact it is well to know in case of buying any kind of grain before storing it. A miller taking a farmer's wheat in at harvest to store for grist ought to consider the moisture proposition.

Measurement of Wood.

Often it falls to the lot of a miller to measure wood in the cord, and many mills use wood for fuel.

A cord of wood contains 128 cubic feet.

Multiply the height, breadth and length together in feet, which gives the cubic feet, and divide the quotient by 128, which gives the cords in the pile.

Coal Measurement in Bin.

Multiply the length, breadth and depth together in feet, which gives the cubic feet, and multiply the result by 54 for anthracite, and by 50 for bituminous coal, and the result will give the number of pounds.

For short tons divide the pounds by 2000.

For long tons divide the pounds by 2240.

Heating Value of Fuels.

The following are the approximate heating values of fuels—pounds of water evaporated by one pound of fuel:

Straw 1.9; wood 3.1; peat 3.8; coke 6.4; coal 7.9; petroleum 14.6.

To Find Contents of Round Bins.

Multiply the diameter by the diameter, and that by the depth, all in feet, which gives the cubic feet; and multiply by .63, which gives the capacity in bushels.

If the measurements are in inches proceed as above and multiply the quotient by .000364, which gives the bushels in round bin.

To Find Speed or Size of Pulleys.

To find revolutions of driven when driver is known:

Diameter of driver is 10 inches, speed of driver is 200 revolutions, driver diameter is 20 inches.

Multiply the revolutions of driver by the diameter of driving pulley, and divide by the driven pulley, which gives the revolutions per minute.

Arithmetical example—

D. 10 x R. 200 = 2000 ÷ D. D. 20, result 200 revolutions.

To find size of driven pulley when revolutions are known:

Driving pulley is 20 inches in diameter, speed of driver 200 revolutions, speed of driven shaft is 75 revolutions.

Multiply the diameter of driver by its revolutions, and divide the quotient by the speed of driven shaft, and the result is the size in inches of driven pulley.

Example arithmetically—

D. 20-in. x R. 200 = 4000 R. ÷ D. S. 75 gives diameter of driven pulley 53.33 inches.

Cubic Measure.

1728 cubic inches equals 1 cubic foot.
27 cubic feet equals 1 square yard.
16 cubic feet equals 1 cord foot.
128 cubic feet equals 1 cord.

Circular Measure.

60 thirds equals 1 second.
60 seconds equals 1 minute.
60 minutes equals 1 degree.
90 degrees equals 1 quadrant.
360 degrees equals 1 circle.

Square Measure.

144 square inches equals 1 square foot.
9 square feet equals 1 square yard.
30¼ " yards equals 1 rod.
160 " rods equals 1 acre.
640 acres equals 1 square mile.

Dry Measure.

4 gills equals 1 pint.
2 pints equals 1 quart.
8 quarts equals 1 peck.
4 pecks equals 1 bushel.

Liquid Measure.

4 gills equals 1 pint.
2 pints equals 1 quart.
4 quarts equals 1 gallon.
30½ gals. equals 1 barrel.
63 " equals 1 hogshead.

Linear Measure.

12 inches equals 1 foot.
3 feet equals 1 yard.
5½ yards equals 1 rod.
320 rods equals 1 mile.

Avoirdupois Weight.

16 drams equals 1 ounce.
16 ounces equals 1 pound.
100 pounds equals 1 hundredweight.
20 cwt or 2000 pounds equals 1 ton.
2240 pounds equals 1 long ton.

Relative Equivalents of the Metric System.

31.1 grams equals 1 ounce, avoirdupois.
1 liter equals 1.06 quarts, liquid measure.
1 hectolitor equals 26.4 gallons, liquid measure.
1 hectolitor equals 2.84 bushels, dry measure.
1 meter equals 39.37 inches, or 3.28 feet.
1 kilometer equals 1093 yeards.
1 cubic meter equals 35.31 cubic feet.

Chapter LIV.

THE WORLD WHEAT HARVESTING.

January: Argentine Republic, New Zealand, Chili and Australia.
February and March: India, Lower Egypt, Asia Minor, Persia, Syria, Cyprus, Mexico and Cuba.
May: Algeria, Texas, China, Central Asia, Morocco.
June: Mississippi, Oregon, California, Georgia, Alabama, South Carolina, North Carolina, Kentucky, Virginia, West Virginia, Tennessee, Kansas, Utah, Arkansas, Missouri, Colorado, Turkey, Italy, Greece, Portugal, Spain, South of France.
July: New York, Pennsylvania, New England, "Six States," Indiana, Ohio, Michigan, Illinois, Iowa, Wisconsin, Nebraska, Southern Minnesota, Bulgaria, Roumania, Upper Canada, Austria, Hungary, Germany, South of Russia, South of England, Switzerland.
August: Central and North Minnesota, Lower Canada, Manitoba, Dakota, Holland, Belgium, Columbia, Denmark, Great Britain, Poland, Central Russia.
September and October: Norway, Sweden, Scotland, North Russia.
November: South Africa, Peru.
December: Burmah.

The above dates of harvesting are approximately true, some countries passing into other months very slightly.

Chapter LV.

ABBREVIATIONS USEFUL TO MILLERS AND MILL OWNERS.

Acct.	Account.
A. D.	"Anno Domino" In the Year of Our Lord.
Ad. Lib.	"As Libitim" at will or at option.
Amt.	Amount.
Anon.	Anonymous.
Ans.	Answer.
Atty.	Attorney.
Av.	Avoirdupois weight.
B. C.	Before Christ.
Bk.	Bank.
C. C. P.	Court of Common Pleas.
C. E.	Civil Engineer.
C. H.	Court House.
Ch. or Chap.	Chapter.
C. J. or Ch. J.	Chief Justice.
Clk.	Clerk.
C. M.	Common Meter.
Co.	County; Company.
Cong.	Congress.
Cr.	Creditor.
Ct.	Cent.
Cwt.	Hundredweight.
Deft.	Defendant.
Do.	Ditto; the same.
Dolls.	Dollars.
Doz.	Dozen.

Dr.	Doctor, Debtor or Dram.
D.	Penny or Pence; "Denarius."
Dwt.	Pennyweight.
Dep.	Department; Deputy.
Ed.	Editor; Edition.
E. E.	Errors Excepted.
Esq.	Esquire.
Etc.	Et Cetra; and other things.
Exch.	Exchange.
Exr.	Executor.
Fahr.	Fahrenheit.
Cent. or C.	Centigrade.
Cts.	Cents.
Fig.	Figure.
Fol.	Page; Folio.
Ft.	Feet, foot or fort.
Gal.	Gallon.
Gr.	Grain.
Hhd.	Hogshead.
Inst.	Instant, or present month.
Lb. or ℔	Item; the same.
L. or £	"Libra" or a pound sterling.
Lb.	"Libre," a pound Avoirdupois.
Mdlle.	Mademoiselle.
Mem.	Memorandum.
Messrs.	Messieurs.
Mme.	Madame.
M. P.	Member of Parliment; Municipal or Metropolitan Police.
Mr.	Master, pronounced mister.
Mrs.	Mistress, pronounced missers.
M. E.	Milling Engineer or Mill Builder.

Chapter LVI.

MILLERS EXCHANGE TABLE.

Look for the weight of wheat in the middle column in pounds, and for the pounds of flour in the top line. In the angle of the respective line and column will be found the weight of flour required.

Thus 160 pounds of wheat gives 96 pounds of flour at 36 pounds of it per bushel. If the exact weight of wheat is not found divide it into two or more numbers.

25	26	27	28	30	31	32	W'ght	33	34	35	36	37	38	40
2	2	2	2	3	3	3	**5**	3	3	3	3	3	3	3
4	4	5	5	5	5	5	**10**	6		6 6	6	6	6	7
8	9	9	9	10	10	11	**20**	11	11	12	12	12	13	13
13	13	14	14	15	16	16	**30**	17	17	18	18	19	19	20
17	17	18	19	20	21	21	**40**	22	23	23	24	25	25	27
21	22	23	23	25	26	27	**50**	28	28	29	30	31	32	31
25	26	27	28	30	31	32	**60**	33	34	35	36	37	38	40
29	30	32	33	35	36	37	**70**	39	40	41	42	43	44	47
33	35	36	37	40	41	43	**80**	44	45	47	48	49	51	53
38	39	41	42	45	47	48	**90**	50	51	53	54	56	57	60
42	43	45	47	50	52	53	**100**	55	57	58	60	62	63	67
46	48	50	51	55	57	59	**110**	61	62	64	66	68	70	73
50	52	54	56	60	62	64	**120**	66	68	70	72	74	76	80
54	56	59	61	65	67	69	**130**	72	74	76	78	80	82	87
58	61	63	65	70	72	75	**140**	77	79	82	84	86	89	93
63	65	68	70	75	78	80	**150**	83	85	88	90	93	95	100
67	69	72	75	80	83	85	**160**	88	91	93	96	99	101	107
71	74	77	79	85	88	91	**170**	94	96	99	102	108	105	113
75	78	81	84	90	93	96	**180**	99	102	105	108	111	114	120
79	82	86	89	95	98	101	**190**	105	108	111	114	117	120	127
83	87	90	93	100	103	107	**200**	110	113	117	120	123	124	133
88	91	95	98	105	109	112	**210**	116	119	123	126	130	133	140
92	95	99	103	110	114	117	**220**	121	125	128	132	136	139	147
96	100	104	107	115	119	123	**230**	127	130	134	138	142	146	153
100	104	108	112	120	124	128	**240**	132	136	140	144	148	152	160
104	108	113	117	125	129	133	**250**	138	142	146	150	154	158	167
108	113	117	121	130	134	139	**260**	143	147	152	156	160	165	173
113	117	122	126	135	140	144	**270**	149	153	158	162	167	171	180

25	26	27	28	30	31	32	W'ght	33	34	35	36	37	38	40
117	121	126	131	140	145	149	**280**	154	159	163	168	173	177	187
121	126	131	135	145	150	155	**290**	160	164	169	174	179	184	193
125	130	135	140	150	155	160	**300**	165	170	175	180	185	190	200
129	134	140	145	155	160	165	**310**	171	176	181	186	191	196	207
133	139	144	149	160	165	171	**320**	176	181	187	192	197	203	213
138	143	149	154	165	171	176	**330**	182	187	193	198	204	209	220
142	147	153	159	170	176	181	**340**	187	193	198	204	210	215	227
146	152	158	163	175	181	187	**350**	193	198	204	210	216	222	233
150	156	162	168	180	186	192	**360**	198	204	210	216	222	228	240
154	160	167	173	185	191	197	**370**	204	210	216	222	228	234	247
158	165	171	177	190	196	203	**380**	209	215	222	228	234	241	253
163	169	176	182	195	202	208	**390**	215	221	228	234	241	247	260
167	173	180	187	200	207	213	**400**	220	227	233	240	247	253	267
171	178	185	191	205	212	219	**410**	226	232	239	246	253	260	273
175	182	189	196	210	217	224	**420**	231	238	245	252	259	266	280
179	186	194	201	215	222	229	**430**	237	244	257	258	265	272	287
183	191	198	205	220	227	235	**440**	242	249	257	264	271	279	293
188	195	203	210	225	233	240	**450**	248	255	263	270	278	285	300
192	199	207	215	230	238	245	**460**	253	261	268	276	284	291	307
196	204	212	219	235	243	251	**470**	259	266	274	282	290	298	313
200	208	216	224	240	245	256	**480**	264	272	280	288	296	304	320
204	212	221	229	245	253	261	**490**	270	278	286	294	302	310	327
208	217	225	233	250	255	267	**500**	275	283	292	300	308	317	333
250	260	270	280	300	310	320	**600**	330	340	350	360	370	380	400
292	303	315	327	350	362	373	**700**	385	394	400	420	432	443	467
333	347	360	373	400	413	427	**800**	440	453	467	480	493	507	533
375	390	405	420	450	465	480	**900**	495	510	525	540	555	570	600
417	433	450	464	500	517	533	**1000**	550	567	583	600	617	633	667
625	650	675	700	750	775	800	**1500**	825	850	875	900	925	950	1000
833	867	900	933	1000	1033	1067	**2000**	1100	1133	1167	1200	1233	1267	1333
1042	1083	1125	1167	1250	1292	1333	**2500**	1375	1417	1458	1500	1542	1583	1667
1250	1300	1350	1400	1550	1550	1600	**3000**	1650	1700	1750	1800	1850	1900	2000

It is an easy matter for a miller to transfer this table to a large cardboard and hang it in the mill where it may be seen at a glance, the rate of exchange, saving much figuring and many mistakes.

To stop and figure means much time wasted both for mill employees, also the customers.

CHAPTER LVII.

MEDLEY OF USEFUL INFORMATION.

The Value of Foreign Coins, Approximately.

Argentine Republic	Peso	Gold	and	Silver	$0.96.5
Australia	Pound, 1852	"			5.32
Austria	Florin			"	.42
Belgium	Franc	"	"	"	.19.3
Bolivia	Boliviano			"	.35
Brazil	Milreis of 1000 reis.	"			.54.6
Canada	Dollar	"			1.00
Chili	Peso	"	"	"	.91.2
China	Tael			"	1.25.6
Cuba	Peso	"	"	"	.92.6
Denmark	Crown	"			.26.8
Ecuador	Sucre			"	.75.1
Egypt	Piaster	"			.04.9
France	Franc	"	"	"	.19.3
Germany	Mark	"			.23.8
Great Britain	Pound Sterling	"			4.86.6
Greece	Drachma	"	"	"	.19.3
Hindustan	Ruppe				.42
Hayti	Gourde	"	"	"	.96.5
India	Rupee			"	.40.4
Italy	Lira	"	"	"	.19.3
Japan	Yen			"	.91.7
Siberia	Dollars	"			1.00
Mexico	Peso			"	.57.3
Neherlands	Florin	"	"	"	.40.2
Norway	Crown	"			.26.8
Peru	Sol			"	.85
Portugal	Milreis of 1000 reis.	"			1.08
Russia	Rouble of 100 copecks			"	.68
Spain	Presta of 100 centimes	"	"	"	.19.3
Sweden	Crown	"			.26.8
Switzerland	Franc	"	"	"	.19.3
Turkey	Piasters	"			.00.04
U. S. Columbia	Peso			"	.85
Venezuela	Bolivar	"	"	"	.17

These figures were secured some years ago, but it gives the approximate value of the coins.

The coins fluctuate so much in value in some countries that are continually at war internally and externally.

PERCENTAGE OF OIL IN SEEDS.

Walnut	40 to 60 per cent.	Hemp Seed	14 to 25 per cent.
Castor Oil Seed	60 to .... per cent.	Linseed	11 to 22 per cent.
Hasel Nuts	60 to .... per cent.	Black Mustard Seed	15 to .... per cent.
Sweet Almonds	45 to 54 per cent.	Sunflower Seed	15 to 18 per cent.
Poppy Seed	56 to 63 per cent.	Corn	7 to .... per cent.
Oily Radish Seed	50 to .... per cent.	Oats	6 to .... per cent.
White Mustard	36 to 38 per cent.	Barley	2 to .... per cent.
Colza Seed	36 to 38 per cent.	Wheat	2 to .... per cent.
Rape Seed	30 to 36 per cent.	Rye	1.8 to .... per cent.
Cottonseed	18 to .... per cent.		

These figures are as near correct as possible, and will serve to show their relative value as feed.

Millers often hear of "Bull" and "Bear" and I will give the definition.

The Bull is one that buys stocks or grain and operates to have the market move upwards.

The Bear is one who operates to have the market fall, in order that he might realize on stocks or grain that he has bought.

A "cornerer" is when a bear cannot buy or borrow stocks or grain in fulfillment of their contracts.

"Overload" is when a bull cannot take and make payments of his stock or grain purchases.

"Short" is when a party sells stock or grain when they have none and expect to borrow or buy to deliver on contracts.

"Long" is when a person or firm has a plentiful supply of grain or stocks.

A "Pool" or "Ring" is when a combination is formed to control prices of stocks or grain.

A "Put" or "Call" is when a person gives so much per cent. for the option of buying or selling so much stock or grain on a certain fixed day, at a price arranged the day the option is given.

I give below a list of the milling press, and which are the best friends of the operative and mill owner:

The American Miller, Chicago, Ill., U. S. A.
The Dixie Miller, Nashville, Tenn., U. S. A.
The Northwestern Miller, Minneapolis, Minn., U. S. A.
The Operative Miller, Chicago, Ill., U. S. A.
The Canadian Miller and Cerealist, Montreal, Canada.
The Miller's Review, Philadelphia, Pa., U. S. A.
Milling, Liverpool, England.
The Miller, London, England.
The Modern Miller, St. Louis, Mo., U. S. A.
The Russian Miller, St. Petersburg, Russia.